UNIVERSITY OF ALBERTA

ACQUISITION DIFFERENCES IN MATCHING- AND ODDITY-TO-SAMPLE

by

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ABSTRACT

This study was designed to examine the manner in
which acquisition of a complex discrimination progressed,
and how it might differ under different procedural
variables.

Budgerigars were used as subjects. An apparatus which
permitted three key discriminative key press responding
is described.

A 2 X 3 factorial design with two birds per treatment
was used to investigate both matching-to-sample and
oddity-to-sample acquisition with three different
correction procedures. The basic task involved a
three key-two color complex discrimination. A response
to a centered sample key turned on two comparison keys -
one the same color as the sample and one different.
Reinforcement was programmed either for a response to
the comparison key which matched the sample, or to the
key which differed. An incorrect response had one of
three consequences, depending upon treatment group;
a) no consequence: straight-correction b) termination
of trial and repetition of that trial: modified
correction c) termination of trial and advance to
the next trial: noncorrection.

Acquisition was found to vary in terms of position
preference, initial level of percent correct responding
and total number of sessions to reach criterion.
Variations in acquisition were a function of both
correction procedure and matching-oddity procedure.
Initial position preferences were quite strong for the
noncorrection subjects, particularly those on the matching
procedure, but were either much less marked or absent in
the other two correction procedure conditions. The
initial level of percent correct responding was higher
for the oddity subjects than for the matching subjects.
This difference was smallest for the subjects on the

noncorrection procedure.   High asymptotic levels of
responding were reached by all except the subjects on
the matching X straight-correction condition.   In that
condition one subject leveled off at chance and the
other stopped responding.   The noncorrection procedure
subjects reached asymptote more rapidly than the subjects
on the other correction procedures.

The results are discussed with respect to previous
work reporting matching-oddity acquisition differences,
and are found to provide a rationale for the ambiguity
which existed.   The correction procedure used is considered
to be the chief source of the differences in these
studies.   It is concluded that acquisition appears to
proceed according to a successive, rather than a
simultaneous discrimination, and is facilitated by the
early use of position cues.

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INTRODUCTION

Responding to a relation among stimuli rather than
to a stimulus alone enables an organism to deal with its
environment on some basis other than a one-to-one stimulus -
response basis. One of the most elementary relationships
which can be abstracted from an array of stimuli is that
of same - different. An experimental procedure which
investigates this relation is "matching-to-sample": A
stimulus is presented as a sample to the subject and the
subject is taught to select a stimulus which is the same
as the sample from among two or more subsequently presented
stimuli. Another such procedure, "oddity-to-sample",
involves selection of a subsequent stimulus which is
different from the sample. While it might appear that
these two procedures are logically converse, it has been
found that the acquisition of matching-to-sample differs
from that of oddity-to-sample (Berryman, Cumming, Cohen
& Johnson, 1965; Ginsburg, 1957). Does this difference
between learning to choose that which is the same and that
which is different represent some intrinsic aspect of the
learning process or does it represent an artifact of
experimental procedures?

Learning

If this difference in acquisition between matching-to-
sample and oddity-to-sample is attributable to learning,
then learning must evolve from systematic rather than
random behavior. The conditional discrimination is a
procedure which enables investigating whether behavior
changes in systematic stages which may favor one problem or
the other.

Random and systematic behavior interpretations. The
classical distinction between continuity and noncontinuity
theories of learning (Spence, 1951) recognizes two
alternatives. On the noncontinuity side of the arguement,

Krechevsky (1932) wrote that "Learning consists of changing from one systematic, generalized, purposive way of behaving to another and another until the problem is solved (pg. 532). These "...ways of behaving" were called hypotheses by Krechevsky who considered presolution hypotheses or "false solutions" as necessary, although not directly relevant, to the final solution of the problem. Likewise Lashley (1929) contended that "There are many indications that animals in the problem-box situation experiment with many solutions... Similarly in the discrimination box, response to position, to illumination or to cues from the experimenter's movements usually precede the reactions to the light and represent attempted solutions which are within the rats' customary range of activity (pg. 135)." Lashley considered these presolution hypotheses as irrelevant to the real solution.

On the other hand Spence (1936) considered behavior during the presolution period as quite relevant to the solution of a problem. Behavior, according to Spence, did not proceed in a chance or haphazard manner, but instead with what he called directive tendencies. These tendencies, brought into the situation by the subject partly as a result of experience, consisted of already learned associations and were initiated according to their respective strengths.

If learning is noncontinuous, then variations in the irrelevant presolution behavior on a matching or an oddity problem would have to be due to procedural variables. The irrelevancy of the behavior would preclude the influence of any consistent differences on solution. Therefore, even if differences existed they would not be part of the learning process. If learning was continuous (Spence, 1936), then the acquisition of different problems might proceed in different ways. Differences in the acquisition of a matching and an oddity problem could

be inherent in the learning process.

Testing alternatives via conditional discrimination.
Determining whether learning proceeds in a noncontinuous or
a continuous fashion would help to indicate whether the
matching and oddity acquisition differences could be due
to training procedures or to the learning process.   The
conditional discrimination procedure facilitates investigation
of this question because it provides for a number of
response alternatives during the presolution period.   The
number of alternatives varies with the number of conditions
built into the experimental procedure.   If learning is
noncontinuous, then training alone must underlie the
differences since behavior during presolution, being
irrelevant to the solution, cannot vary on different
problems in any way which would affect solution.   If
learning is continuous, then there may be some patterns of
behavior which originate during presolution which could
differentially favor the acquisition of matching-to-sample
or oddity-to-sample.   These patterns of behavior should
be evident in a record of responding as recurrent stimulus -
response pairings.   Such a finding would not preclude
that the acquisition differences were training related, and
this possibility would also have to be investigated.

The problem of conditional discrimination has
received considerable attention in recent years under the
guise of matching-to-sample, a restricted case of a
conditional discrimination in which the conditional
stimulus plays an active part in the discrimination
(Blough, 1959; Cumming & Berryman, 1961, 1965; Ferster,
1960).   In such a procedure one stimulus is presented as
a sample.   The subject is required to pick from among two
or more other stimuli the one which is the same as, or
matches, the sample.   The procedure is frequently
accompanied by another called nonmatching (Ginsburg, 1957;

Harlow, 1942) or oddity (Berryman, et al., 1965), in
which the subject must pick from among the comparison
stimuli the one which does not match the sample (or not
pick the one which does match).   (The term oddity
has also been used as the name for a slightly different
procedure in which the subject must pick from among three
or more stimuli the one which differs from all the others,
the one cue being the oddness (Moon & Harlow, 1955;
Robinson, 1933).   The conditional role of a sample
stimulus, which is basic to matching-to-sample, is lacking
in this other oddity procedure.   These two oddity
procedures must not be confused.)

A conditional discrimination paradigm lends itself
well to an analysis of presolution behavior because it
provides for many possible stimulus - response pairs to
occur during solution of the problem.   The number available
depends upon the complexity of the discrimination problem.
Cumming and Berryman (1965) discussed the study of stimulus -
response pair patterns during presolution within the
context of matching- and oddity-to-sample.   They report
that there do exist what they call incorrect 'hypotheses'
(observed correlations between stimuli and responses)
during presolution.   They found that they could manipulate
these 'hypotheses' to a certain extent by the experimental
control of certain variables.   For instance, "...when
we have programmed reinforcement for simultaneous matching,
the birds display an almost complete position preference,
However, when the reinforcements are programmed for
responses to the odd stimulus, no such substantial position
habits emerge (pg. 325)."

The conditional discrimination paradigm provides a
basis for the analysis of presolution behavior, but it will
be necessary to examine the more recent work thoroughly
before using it as a tool, so to speak, for looking at some
other aspect of learning.

The more recent matching-to-sample work (Cumming &

Berryman, 1961; Ginsburg, 1957; Harlow, 1951; Skinner, 1950; Young & Harlow, 1943) has revealed discrepancies in the rate of acquisition of matching as opposed to oddity. Skinner reported that matching "is apparently no easier than" oddity. Ginsburg reported data which indicated that matching was not only no easier to acquire than oddity, but was in fact harder (Table 1). It began at a lower level of percent correct responding and took more time (more trials) to reach criterion. Berryman, et al. (1965) interpreted Skinner's statement as meaning that matching and oddity were acquired with equal ease and pointed to the "contradictory findings" of Skinner and Ginsburg. Berryman, et al. presented data contradictory to both Skinner's and Ginsburg's which showed that although oddity performance began at a higher percentage of correct responding as in Ginsburg's data, it improved at a slower rate than matching and did not reach as high a level of correct responding as matching performance after 20 sessions (Table 2).

Cumming & Berryman (1965) suggested a post hoc explanation of the acquisition difference of matching and oddity based on inference from their oddity transfer experiments. They were using three stimulus colors instead of two. One comparison stimulus was always the same as the sample and the second comparison stimulus could be either of two other colors. Following acquisition of oddity-to-sample a fourth stimulus color was substituted for one of the original three. If the original stimulus colors had been red, green and blue, then yellow was substituted for blue. As a result of this substitution three distinct stimulus patterns emerged. Some patterns were the same as the original acquisition patterns - red and green on the sample key and on both comparison keys. On other patterns the sample was now yellow, and the comparison stimuli were yellow on one side, and either red or green on the other side. On

Table 1

*Ginsburg's Data

Initial level percent correct		Number of trials to reach 80% correct	
Subjects		Subjects	
Matching	Oddity	Matching	Oddity
55	90	410	0
50	70	720	80
45	60	750	100
35	55	760	140
25	55	1080	150
20	50	1660	160
	50		200
$\overline{X} = 38$	$\overline{X} = 61$	$\overline{X} = 897$	$\overline{X} = 119$

* initial level (1955)
  trials to 80% (1957)

Table 2

*Cumming and Berryman's Data

Initial level percent correct		Number of trials to reach 80% correct	
Subjects		Subjects	
Matching	Oddity	Matching	Oddity
	75	490	300
only	73	440	610
averaged	67	730	660
data	67		930
given	57		1010
	52		1390
$\overline{X} = 50$	$\overline{X} = 65$	$\overline{X} = 553$	$\overline{X} = 817$

*1965

the third type of pattern the sample was red or green and one of the comparison stimuli was now yellow. Cumming and Berryman found that the level of correct responding remained unchanged for the first sort of pattern. Oddity performance was disrupted for both of the other two types of patterns, particularly the last, when the new color was present only as one of the comparison stimuli.

From these data Cumming and Berryman (1965) suggested that the sample stimulus functioned as a discriminative stimulus to 'respond' (S^D) rather than a discriminative stimulus to 'not respond' (S^Δ). The sample was telling the subject which comparison stimulus was correct, not which one was incorrect. If the sample was instructing which stimulus was incorrect the performance on the third type of pattern would not be as severely disrupted as on the second type of pattern since the instruction would not involve the new color.

A matching transfer experiment results in the same stimulus pattern changes, but because of the different relationship of sample to correct response the orderly gradations of disruption of performance would not be expected. When the new color was the sample, performance might be disrupted whether the sample was acting as an S^D or an S^Δ. On the third type of pattern, when the new color was the odd comparison, the instructions of the sample as either an S^D or an S^Δ would not include the new color, hence performance would not be disrupted.

An S^D function in the oddity context is more complex than in the matching context. In the matching, a red sample as an S^D instructs to "peck a red comparison stimulus". In oddity a red sample as an S^D instructs to "peck a blue or green comparison, whichever is available", a much more complex instruction. Similarly with a green sample it instructs to "peck green" or "peck red or blue", etc.

Ginsburg (1957) used only two color stimuli, in

which case a matching red sample instructed to "peck red" and an oddity red sample to "peck green": neither was more complex than the other in terms of the Cumming and Berryman analysis. Because of this Ginsburg's data should show matching and oddity acquisition rates to be more nearly equal than were those of Berryman, et al. Unfortunately the differences in the criterion of solution used by Ginsburg and Berryman, et al. make it difficult to compare the two studies or even to compare Ginsburg's matching and oddity rates beyond the 80 percent correct level of responding, as Berryman, et al. did.

If Skinner's statement that matching was no easier than oddity is taken to mean that their rates of acquisition were the same, this would support Cumming and Berryman's $S^D - S^\Delta$ suggestion since Skinner used two color stimuli.

There are these three discrepant reports in the literature. For Skinner matching- and oddity-to-sample are learned in the same way. Ginsburg's subjects learned matching-to-sample with more difficulty than they learned oddity-to-sample. Berryman, et al. found that while responding on oddity-to-sample was initially superior to that on matching-to-sample, the difference was reversed later in acquisition. What is it about these studies which is causing these conflicting reports?

Experimental Procedure

Preliminary training, correction procedures and the criteria for solution are aspects of experimental procedures which are known to have differential effects on learning. Could these effects account for the difference between matching and oddity learning?

Training procedures differentially affect acquisition. Before a subject can be expected to perform in any sort of learning experiment it is necessary to train him to make the appropriate response on the manipulandum provided. How this preliminary training is acheived may

have a subsequent effect on behavior and differentially favor matching or oddity acquisition (Berryman, et al., 1965; Devine & Iven, 1969; Nissen, Blum & Blum, 1948; Young & Harlow, 1943). The method used by Berryman, et al. involved response contingent primary reinforcement on all of the stimuli (keys and color) to be used in the matching and oddity procedures. After a certain number of reinforcements had been delivered the matching or oddity procedure was begun with primary reinforcement contingent only on responses to the comparison stimuli. Responses to the sample, although secondarily reinforced by the onset of the comparison stimuli, were extinguished with respect to immediate primary reinforcement. Such a procedure of extinction of responding to the sample may initially have facilitated oddity and acted detrimentally on matching performance. If the subject was not reinforced for a response to the sample the effect of this might have been that the next time that color was seen the subject would not respond to it, especially if there was another stimulus color available. That is, he would respond according to oddity-to-sample.

Ginsburg, on the other hand, never reinforced responding on the sample with primary reinforcement. Therefore, his data would not show an enhancement of oddity performance due to such reinforcement. Let us compare the Ginsburg and the Berryman, et al. studies with respect to the relative superiority of matching and oddity.

Initial levels of percent correct responding were higher for oddity than for matching in both the Ginsburg (1957) and the Berryman, et al. studies (Tables 1 and 2). Since initial oddity superiority was evident in both studies, it must not have been related to preliminary training which differed in the two studies. A comparison of time to reach criterion showed that in Ginsburg's study the oddity subjects reached the 80 percent correct criterion sooner (in fewer trials) than Berryman, et al.'s

oddity subjects did.   Berryman, et al.'s method of
preliminary training must not have been facilitating rate
of acquisition.   When Berryman, et al.'s subjects were
run beyond 80 percent the oddity subjects took longer to
reach asymptote than the matching subjects.   On the
basis of this third comparison it could be said that
oddity performance was inferior to matching, but the
reverse relationship in Ginsburg's data is not evident
due to criterion differences.

Correction procedures may also affect acquisition.   The
consequences of an incorrect response in the learning of a
discrimination present a problem.   Some studies employ a
straight-correction procedure, in which there are no
programmed consequences and the organism is free to "correct
his mistake" (Brookshire, 1970; Ginsburg, 1957; Hull &
Spence, 1938; Riopelle, Hill & Rector, 1967).   At the
opposite extreme, a noncorrection procedure is one in
which a wrong response is effective in terminating the
trial and changing the stimulus pattern which will
appear on the next trial (Bitterman, 1966; Brookshire,
1970; Cumming, Berryman & Cohen, 1965).   One variation
of this procedure is to terminate the trial without
changing the stimulus pattern, so that the next trial
is the same (Blough, 1959; Ferster, 1960; Stettner,
Schultz & Levy, 1967).   Such a method shall be referred
to as a modified-correction procedure.

Some types of correction procedures may differentially
facilitate matching or oddity.   For instance, in modified-
correction and straight-correction, especially the latter,
it is possible to have a rapid sequence of 'incorrect
response - correct response - reinforcement'.   The
incorrect response in such a sequence could be secondarily
reinforced by the correct response or by attention to the
correct stimulus (Fowler, Spelt & Wischner, 1967; Robbins,
1969), or even primarily reinforced through chaining
(Bolles, 1967, 1970; Ferster, 1953).   Spence (1936)

considered that there could be a spread of the strengthening of excitatory tendencies to responses more remote in time from the reinforcement, and perhaps even a dispersal of any inhibitory tendencies resulting from nonreinforcement of the incorrect response. Ginsburg (1957) discussed the possibility that if an incorrect - correct response sequence was reinforced that it would facilitate oddity behavior. In both the matching and oddity procedures responding to the two comparison stimuli in succession necessarily would mean responding to an odd stimulus since they would always be different from one another.

In a modified-correction procedure and in a noncorrection procedure it is conceivable that both correct and incorrect responses could be reinforced by the termination of the trial. A stimulus change such as trial termination has been found to have reinforcing properties (Hinde, 1966). However, this effect would be symetrical for matching- and oddity-to-sample. Incorrect responding would not be reinforced at all by stimulus change in straight-correction since it would have no consequences, thus there would be no stimulus change (Ferster, 1953). The effect of a stimulus change type reinforcement of errors would be to slow the progress of both matching and oddity discriminations under conditions of noncorrection and modified-correction. In assessing the relative effect of correction procedure in the Ginsburg and the Berryman, et al. studies, the data in Tables 1 and 2 show that Ginsburg's subjects (straight-correction) began responding at a lower level of percent correct than Berryman, et al.'s subjects (noncorrection). The theory of reinforcement of errors by stimulus change would predict the opposite effect for straight-correction versus noncorrection. In terms of the number of trials to reach the 80 percent correct level of responding, Ginsburg's oddity group was faster than Berryman, et al.'s oddity group. However, Ginsburg's

matching group was slower than Berryman, et al.'s.

  <u>Influence of criterion of solution.</u> The data from different experiments can appear discrepant as a result of differences in the criterion used (Berryman, et al., 1965; Weitz, 1961). Berryman, et al. ran daily sessions of 140 trials until responding reached asymptote. They found that the asymptotic level for matching exceeded that for oddity and reached nearly one hundred percent. Ginsburg used a criterion of sixteen correct responses out of twenty, or 80 percent. Half of his subjects had sessions of twenty trials and the other half had forty trial sessions. The subjects with the forty trial sessions were required to attain 80 percent correct in both the first and second twenty trials. Ginsburg's data (Table 1) showed a mean number of trials to criterion for matching of almost eight times that for oddity. Thus while Berryman, et al. can say that oddity was harder than matching and Ginsburg can say that matching was harder than oddity, their conclusions are not based on comparable data. A proper comparison would have to be made at the 80 percent level in both studies. Berryman, et al.'s data in Table 2 showed that the number of trials to reach an 80 percent correct level was greater for the oddity subjects, a result opposite to Ginsburg's. Since the contradiction between Ginsburg and Berryman, et al. centers on the respective rates of acquisition of matching and oddity, and since Ginsburg did not run to asymptote, the two sets of data cannot be adequately compared on this point.

Aim of the Present Study

  The present study was designed to examine differences in behavior during the acquisition of matching- and oddity-to-sample. At the same time the effects of training factors known to influence acquisition were observed. Preliminary training was designed to minimize the

possibility of differential influences on subsequent
discrimination acquisition and performance.   Subjects
were run on either matching or oddity, and on one of three
correction procedures, either straight-correction,
modified-correction or noncorrection.   Behavioral records
were analyzed in such a way as to reveal whether learning
proceeded in a continuing series of systematic stages
or by means of either random or systematic discontinuous
behavior.   Any response patterns evident during the
period of presolution would be further studied to
determine if they intrinsically favored matching or
oddity learning.

METHOD

Subjects

Most recent studies on matching-to-sample have used the pigeon as a subject (Cumming & Berryman, 1965; Ferster, 1960; Ginsburg, 1957).   It was decided for this research to use budgerigars (Melopsittacus undulatus), although they have been used very little in learning experiments (Brookshire, 1970; Cogan, 1971; Dawson & Foss, 1965; Ginsburg, 1960; Ginsburg & Nilsson, 1971). Space and maintenance considerations were of major importance in this decision, and one would presume that the same basic principles of learning would hold for both birds (Brookshire, 1970; Harlow, 1958; Hinde, 1966). Whether or not the same stimulus - response patterns would be used by pigeons and budgerigars is not at issue, and in fact it is not even known if they would be the same among members of the same species.

Male and female budgerigars were used.   They were obtained locally in groups of eight.   Each group was purchased when the birds were about two months old, at which time they weighed between twenty-five and thirty-five grams.   They were individually housed in standard bird cages and given free access to mixed grain and to water.   When the birds arrived in the laboratory they were banded for identification and randomly assigned to the cells of a 2 X 3 factorial design involving matching and oddity and three different correction procedures.   This left two spare birds from each group to use as replacements in cases of death or failure to condition.

Apparatus

The experimental cage was a 20 X 20 X 27.5 cm. mesh cage with one side and the bottom partially cut out to accomodate the stimulus-response-reinforcement units.   Both the cage and the stimulus-response-reinforcement units

were housed inside a lighted and sound attenuated
Lehigh Valley Medium Universal Cubicle number 132-04.
The stimulus-response-reinforcement units were designed by
T. H. Nilsson and the author. One of these units is shown
in Figure 1. The response keys were horizontal and
required a downward peck of 5.5 grams on the center key
and 3.5 grams on the side keys to close a microswitch. A
downward peck is the natural response for the budgerigar
(Brockway, 1964). The keys themselves were made by
frosting microscope slides with number 600 grit. The
stimulus lights were 28 volt Dialco units number 507-3917
(red, green and white). The lights illuminated the entire
response key. The key units, when inserted into the
experimental cage, were 0.6 cm. off the bottom of the
cage, projected 1.9 cm. into the cage and were spaced
0.3 cm. apart. The actual lighted pecking surface was
1.25 cm. by 2.5 cm.

Reinforcement consisted of a few grains of millet.
It was delivered by means of a solenoid which drew a
slotted arm back into the grain reservoir and then released
it, causing the grain which had dropped into the slot to
fall down the trough, as pictured in Figure 1. Grain
quantity was determined by random arrangement of grain
in the reservoir and varied nonsystematically from 1 to 4.
(There are about 30 grains in the trough in Figure 1).
The experimental cage was dimly illuminated at all times.

Programming was by means of a Computer Mechanisms
Corporation 24VDC tape reader model number 18 in conjunction
with BRS component cards. There were four different
stimulus patterns possible: GRR, RRG, GGR and RGG. (R
indicates red and G indicates green on the left, center
and right keys respectively). Manual switches set the
procedure for oddity or matching, and for which of the
three correction procedures to be in effect.
Responses were recorded on eight 24V Sodeco resettable
counters type TCeZ4E (numbers 629 and 449707). There

17
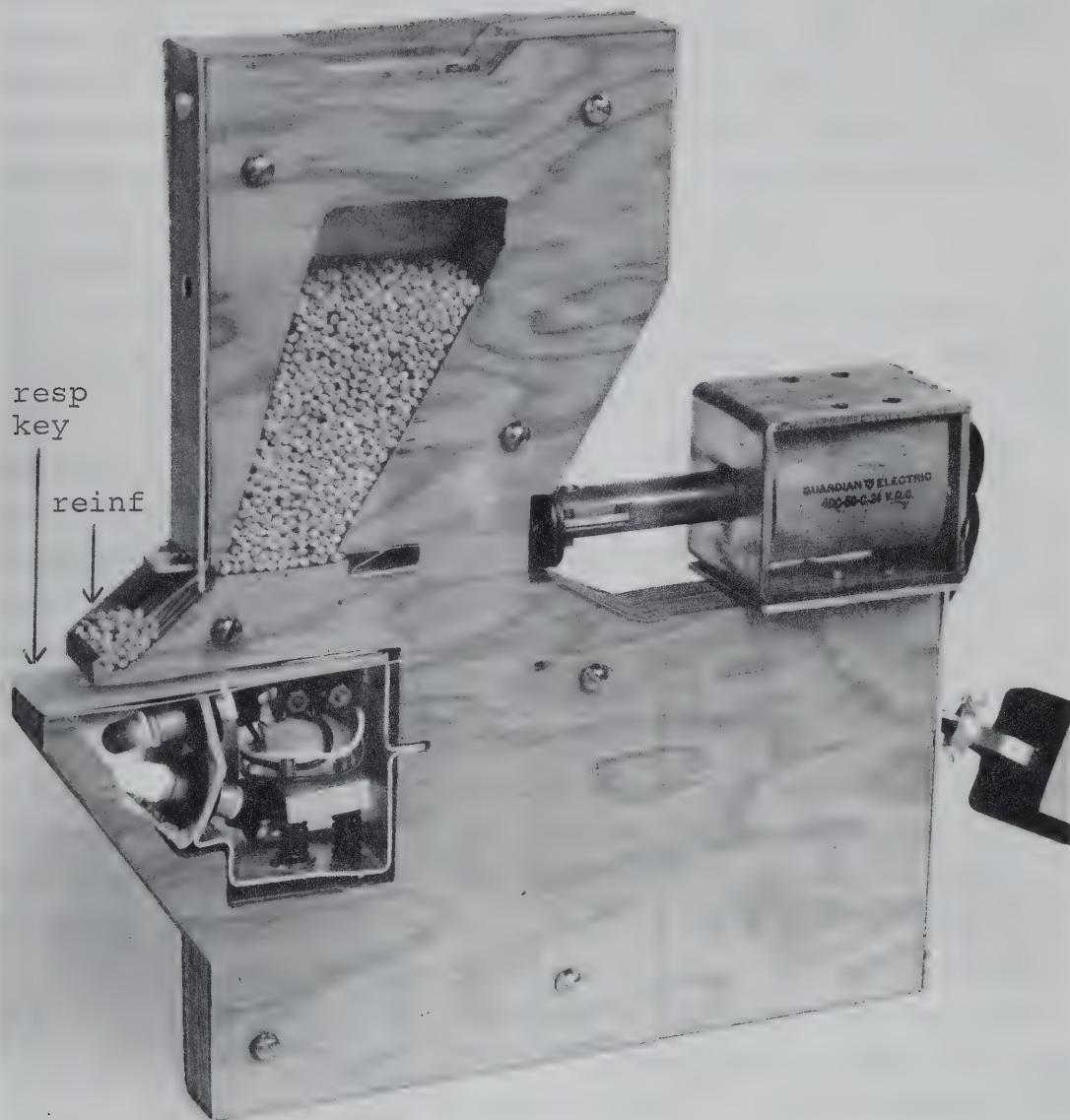
resp
key

reinf

Figure 1.   Stimulus-response-reinforcement unit.

was one counter for left responses and one for right responses on each of the four stimulus patterns. In addition an Esterline Angus operation recorder (Int. trans. type, serial number 163451) sequentially recorded the stimulus pattern (sample and comparison colors), all responses, and reinforcement. The block diagram for the programming and recording circuitry is shown in Figure 2.

Procedure

The birds were weighed daily at approximately the same time each day until their weights had stabilized, about one week. At this time each bird was placed in the experimental apparatus for ten minutes on two consecutive days. These sessions constituted habituation to the experimental situation and during this time a single stimulus-response-reinforcement unit was present in the center position and illuminated with a white light. At random intervals during habituation reinforcement was delivered, the key was simultaneously turned out, and after a delay turned on again. After the second habituation session food was removed from the home cages and the birds were thereafter fed only enough to keep them at between 87 and 92 percent of their stable body weights, and running efficiently.

Beginning with the third session a key peck response was shaped on the single central key. Shaping continued until the bird readily pecked the key fifty times for regular reinforcement two days in succession. Daily shaping sessions were ten to fifteen minutes in length. Initially the cubicle door was open so the experimenter could see when to deliver a reinforcement. Simultaneously with reinforcement the key light was turned out and the intertrial interval begun. This interval was gradually lengthened from about 3 seconds to a maximum of about 30 seconds (Terrace, 1963). Once the subject had begun responding on the key and rein-forcement was being delivered automatically, the cubicle
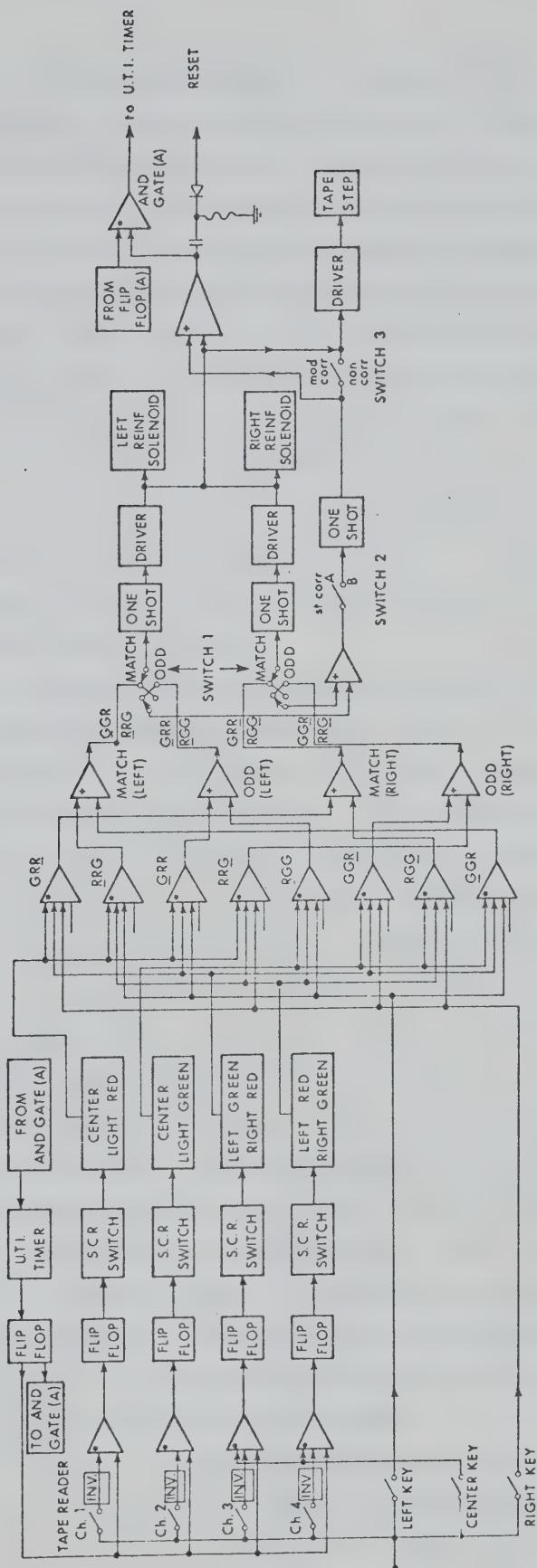
Figure 2. Block diagram of control circuitry.

door was closed.   It was possible to observe the subject
in the cubicle through a small fish eye peep hole in the
door.   Shaping took an average of three sessions,
ranging from one to six sessions for different birds.

On the day after shaping was completed three
stimulus-response-reinforcement units with colored lights
were introduced into the cage.   A balanced nonsystematic
schedule of red and green on the left and the right keys
was programmed, with the center key always dark and pecks
on it ineffective.   Intertrial interval was set at
5 seconds.   Pecks to the lighted key were reinforced during
two sessions of fifty reinforcements each.   In the next
session matching or oddity training and the appropriate
correction procedure were begun.

In all cases a simultaneous discrimination procedure
was in effect.   A trial began with the center key being
turned on.   A response on this key resulted in the side
or comparison keys being turned on.   One of these keys
was the same as the sample and the other was different.
The sample key remained on.   The colors used were red
and green.   Those subjects assigned to the matching
procedure were then required to respond on the comparison
key which was the same color as the sample.   Subjects on
the oddity procedure were required to respond on the
comparison key which was different from the sample.
For all subjects, a correct response resulted simultaneously
in all three keys being turned off and reinforcement
being presented.   A correct response also initiated a
5 second intertrial interval and stepped the paper tape
program to the next trial.   Responses on unlighted
keys were ineffective, as were responses on the sample
key once the comparison keys were lighted.

The consequences of an incorrect response on the
comparison keys varied with the three correction procedures.
In the straight-correction procedure an incorrect response
had no consequence, and the subject was free to respond

again and again until a correct response was made. In the modified-correction procedure an incorrect response was effective in terminating the trial (turning the keys off) and initiating the intertrial interval, but not in stepping the program tape or producing reinforcement. The trial was repeated until a correct response was made. In the noncorrection procedure an incorrect response terminated the trial, initiated the intertrial interval, and stepped the program tape to a new next trial.

A balanced, nonsystematic schedule of the experimental stimulus patterns, shown in Table 3, was programmed by means of paper tape. There were four different combinations of stimulus colors and keys called stimulus patterns: sample key red and comparison keys red on the left and green on the right (RRG), sample key red and comparison keys green on the left and red on the right (GRR), sample key green and comparison keys red on the left and green on the right (RGG), and sample key green and comparison keys green on the left and red on the right (GGR). The program schedule for each session was initiated at random locations on this tape. For purposes of later computer analysis there were no stimulus pattern repetitions programmed on successive trials. All sessions consisted of fifty reinforcements. The birds were run to a criterion of asymptote which was defined as a total of three sessions above 90 percent correct within a run of six successive sessions above 85 percent. This asymptotic level was redefined for the matching X straight-correction condition as less than 2 percent variation over five sessions when it became apparent that the subjects in this condition were not going to reach the high level asymptote. The asymptotes for the birds in this condition were 50 percent for subject number 9 and no responding for subject number 16. These sessions of no responding are not plotted on the figures.

Table 3

Stimulus Programming Sequence

Left Key	Center Key	Right Key	Left Key	Center Key	Right Key
G	R	R	G	G	R
G	G	R	R	G	G
R	R	G	G	R	R
G	R	R	G	G	R
G	G	R	R	R	G
R	G	G	G	R	R
R	R	G	R	G	G
G	G	R	R	R	G
G	R	R	G	G	R
R	G	G	R	G	G
R	R	G	G	R	R
G	G	R	R	R	G
R	G	G	G	G	R
R	R	G	R	G	G
G	R	R	R	R	G
R	G	G	G	G	R
G	G	R	R	G	G
R	G	G	G	R	R
G	R	R	R	R	G
G	G	R	R	G	G
R	G	G	G	R	R
R	R	G	G	G	R
G	R	R	R	R	G
R	G	G	G	R	R
R	R	G	G	G	R
G	R	R	R	R	G

R Red
G Green

RESULTS

The data reported here are from two groups of six birds. Two of these birds were replacements for birds which did not condition beyond the final shaping stage in the matching X modified-correction condition. When the matching-oddity procedure was instituted positional responding precluded reinforcement or program advancement for these birds and they eventually stopped responding altogether.

Figure 3 shows the percentage of correct responses for each subject as a function of sessions until criterion was met. The data are shown in pairs representing the two subjects in each treatment condition. There was close similarity in the performance of the two members of each pair. All subjects began responding at or below chance level (50 percent) on the first session. Except for the subjects in the matching X straight-correction condition they achieved a general increase toward 90 to 100 percent correct responding during subsequent sessions. There are some notable treatment condition differences.
1) Neither subject in the matching X straight-correction condition responded above a chance level. They were the only subjects which did not reach the learning criterion.
2) The number of sessions to reach criterion was less for the noncorrection subjects than the modified-correction subjects. A two-way analysis of variance of the modified- and noncorrection subjects (omitting those on the straight-correction procedure) showed this difference to be not significant (Table 4: $F_{(1,3)}$ = 917: p > .05).
3) All subjects on the matching procedure started at a significantly lower level of percent correct responding than subjects on the oddity procedure (Table 5: $F_{(1,5)}$ = 52.64: p < .01). This initial level of percent correct responding also varied with correction procedure. The difference between the matching and oddity subjects on
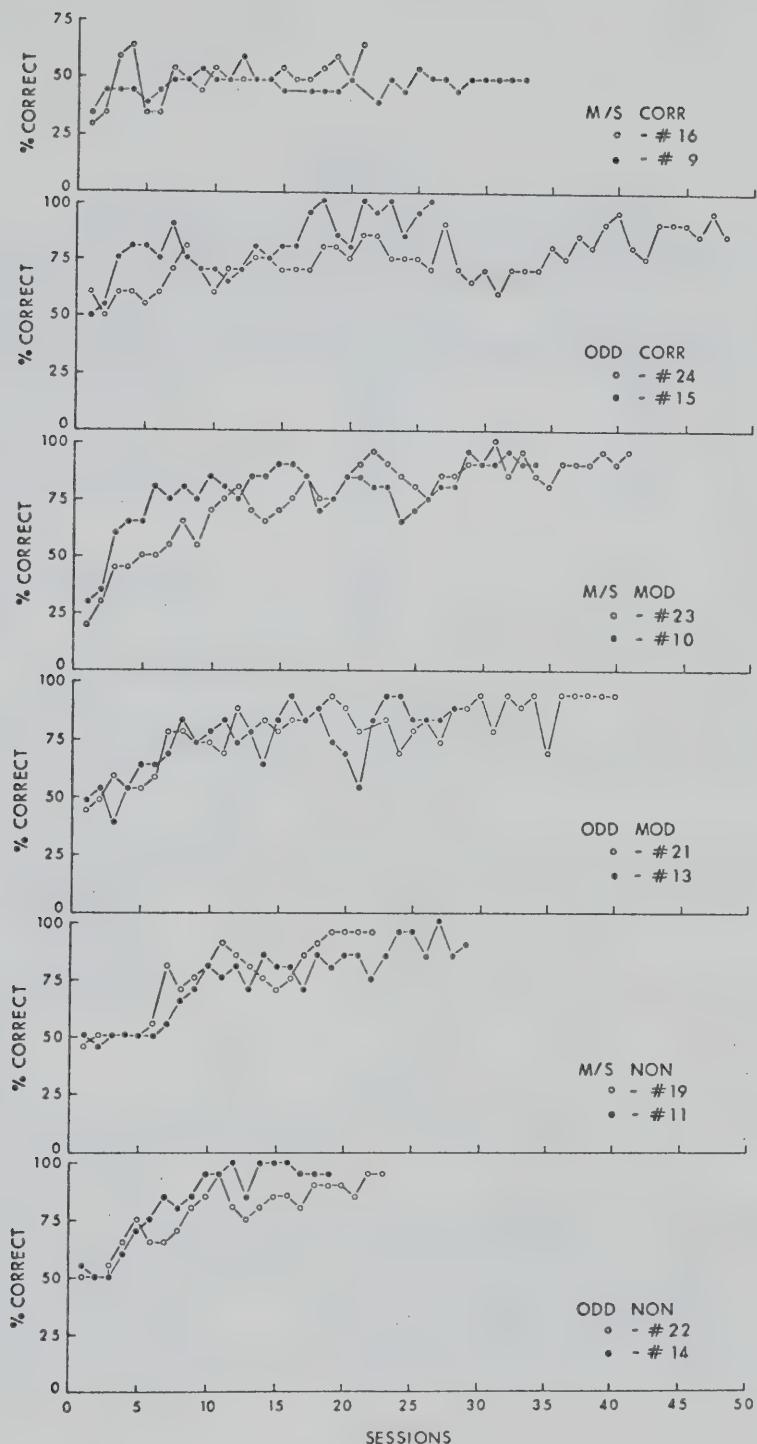
Figure 3.   Percentage of correct responses
            on all trials per session.   The
            curves are grouped according to
            treatment.

Table 4

Number of Sessions to Criterion

Group	Matching	Oddity
St-Corr	33 *	26
	26 *	48
Mod-Corr	34	28
	41	40
Non-Corr	29	19
	22	23

Analysis of Variance of Mod and Non Corr Groups

Source	df	MS	F	p
Replications	1	32.0	1.00	
M/S - Odd(A)	1	32.0	1.00	
Corr Proc(B)	1	312.5	9.70	> .05
A x B	1	0.5	0.02	
Error	3	32.3		

$F_{(p=.05)} = 10.13$

* - These values refer to the number of sessions
to asymptote, but the level reached was not
the high criterion level reached by the
other groups. Because of this the entire
St-Corr group was omitted from the analysis
of variance.

Table 5

Initial Level of Percent Correct Responding

Group	Matching	Oddity
St-Corr	36	52
	32	58
Mod-Corr	28	52
	18	43
Non-Corr	48	53
	43	48

Analysis of Variance

Source	df	MS	F	p
Replications	1	60.75	3.76	>.05
M/S - Odd (A)	1	850.08	52.64	<.01
Corr Proc (B)	2	173.58	10.75	<.05
A x B	2	108.08	6.69	<.05
Error	5	16.15		

$F_{(p=.05)} = 6.61$ & $_{(p=.01)} = 16.26$: df 1 & 5

$F_{(p=.05)} = 5.79$ & $_{(p=.01)} = 13.27$: df 2 & 5

the noncorrection procedure was much smaller than the difference between the matching and oddity subjects on the other two correction procedures (Table 5: $F_{(2,5)} = 10.75$: $p < .05$).

Figure 4 shows the percentage of responses made on the left comparison key as a function of sessions for each subject. Again, the pair within each condition performed similarly. The session to session variability of these results differed with correction procedure. In order to quantify this variability, the standard deviation of the points about the mean of each curve was computed and is shown in Table 6. The noncorrection subjects were most variable from one session to the next, and the modified-correction subjects varied least. Inspection of the curves in Figure 4 shows that the overall high variability of the noncorrection subjects can be attributed to the dichotomous nature of these curves: Strong initial position preferences were abruptly terminated and followed by only moderate position preferences during subsequent sessions. Omitting these initial sessions (the first 20 percent) resulted in the variance values which are shown in parantheses in Table 6. These values are lower and fall roughly between those of the straight-correction and modified-correction subjects.

Figure 4 reveals that for all subjects except those in the matching X straight-correction condition, positional responding was maintained at about the 50 percent level starting sometime prior to reaching criterion. Differences in the extent of positional responding existed in the initial sessions. Position preferences were studied by determining the mean percentage of responding made to the preferred side during the initial 10 percent of the sessions (Table 7). The matching X straight-correction subjects began responding at about chance level and developed a complete position preference (after approximately twelve sessions for subject number 9 and
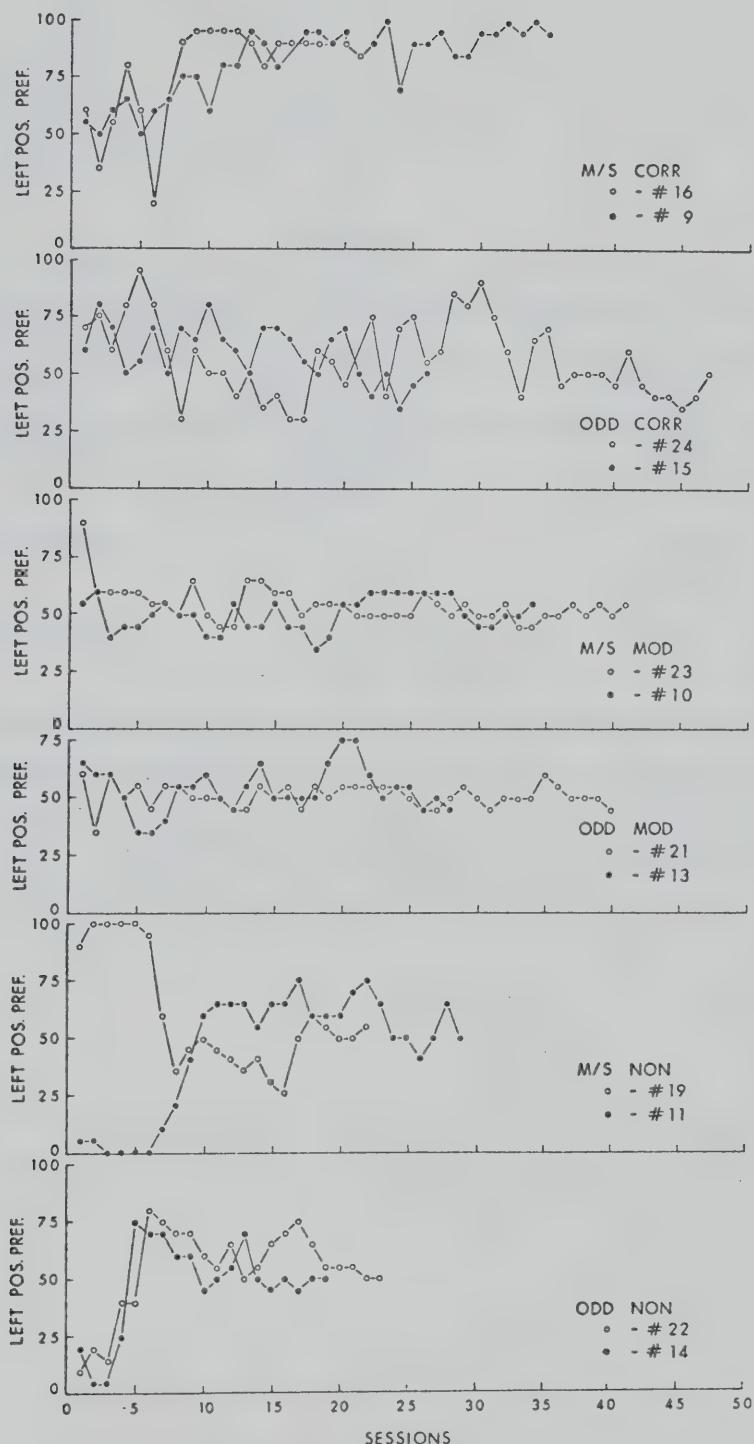
Figure 4.   Percentage of trials in each session to
which a left response was made.   The
curves are grouped according to treatment.

Table 6

Standard Deviation of Position Preference Curves

Group	Matching	Oddity
St-Corr	20.97	16.78
	15.75	11.40
Mod-Corr	7.48	4.80
	7.20	9.71
Non-Corr	25.21 (19.42)	18.81 (8.93)
	26.67 (16.33)	20.57 (10.22)

Note – Standard deviation was measured about
the mean of each curve.   Values in
parentheses were computed omitting
the first 20 percent of the sessions.

Table 7

Percent Positional Responding

Group	Matching	Oddity
St Corr	54	70
	51*	76
Mod Corr	53	62
	66	52
Non Corr	97*	86*
	95	86*

Note.- Positional responding is
       averaged over the first
       10 percent of the sessions.
   * - Mean percentage of responses
       on the right key - unstarred
       values are on left key.

Analysis of Variance

Source	df	MS	F	p
Replications	1	44.08	2.31	
M/S - Odd (A)	1	30.08	1.58	
Corr Proc (B)	2	1314.25	68.88	<.01
A x B	2	268.08	14.05	<.05
Error	5	19.08		

$F_{(p=.05)} = 6.61$ & $_{(p=.01)} = 16.26$: df 1 & 5
$F_{(p=.05)} = 5.79$ & $_{(p=.01)} = 13.27$: df 2 & 5

eight sessions for subject number 16). This preference
was maintained throughout the remainder of the sessions.
The oddity X straight-correction subjects began with
percent-left-responding above chance level, at 70 and
76 percent left, and then responding on the left showed
a slow, general decrease toward chance level. All the
modified-correction subjects exhibited little position
preference. Their positional responding was generally at
chance level, both initially and across all sessions. All
noncorrection subjects began with strong (over 85 percent)
position preferences for one side or the other, then showed
a slight preference for the opposite side, and finally
showed no preference. A two-way analysis of variance of
the initial preference data in Table 7 indicated that
initial position preference was related to correction
procedure ($F_{(2,5)} = 69$: $p < .01$). When strong initial
preferences were shown, the subjects on the matching
procedure showed stronger preferences than the oddity
subjects. This interaction term is significant at the
5 percent level ($F_{(2,5)} = 14$).

A further analysis of position preference across
sessions was undertaken by looking at the percentage of
left responding on each of the four stimulus patterns
(RRG, GRR, RGG and GGR). These data, which were not
plotted, were nearly identical to the positional data in
Figure 4. This indicated that preference did not vary
according to color or position of any stimulus.

In Figure 5 the percentage of trials per session on
which a response occurred to a particular color was plotted
as a function of sessions for the two subjects in each
treatment condition. It is seen that responding was
consistently at or near chance throughout all sessions to
criterion in all groups. At no time did any subjects show
evidence of color preference. Figure 6 shows the percentage
of correct responding as a function of sessions for subjects
in each of the matching conditions. The data are
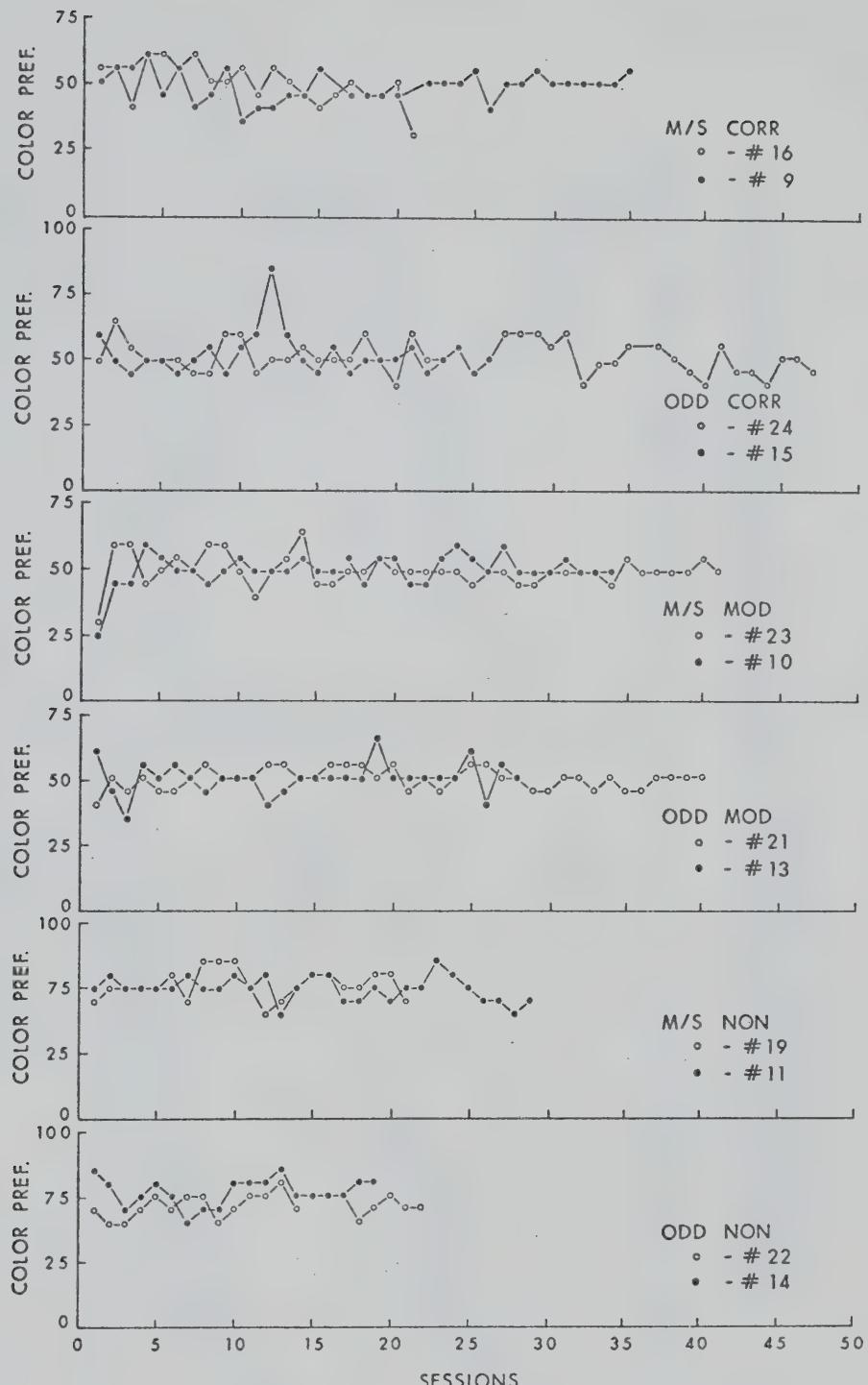
Figure 5.   Percentage of trials in each session
on which a response to red was made.
The curves are grouped according to
treatment.
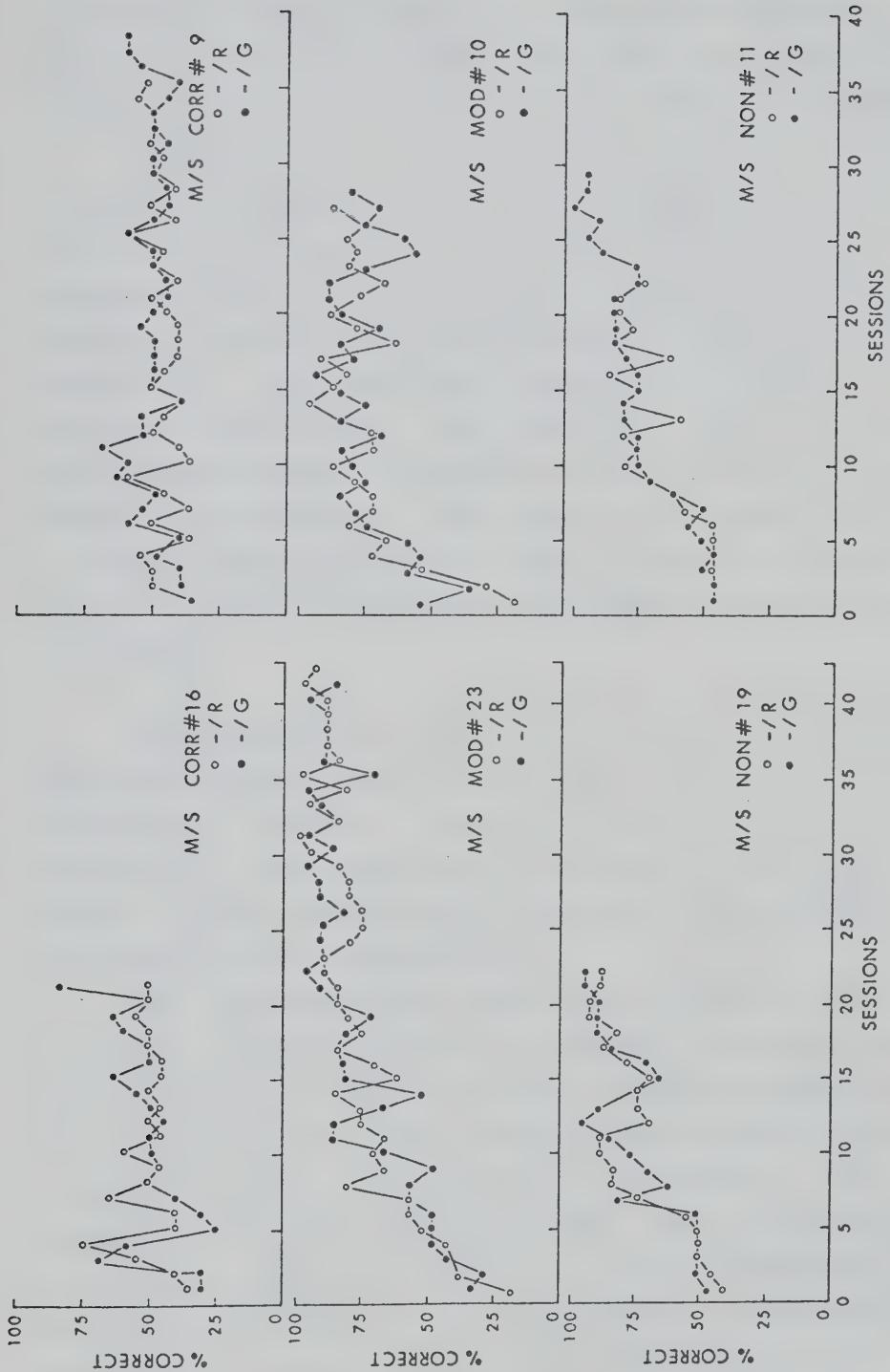
Figure 6. Percent correct responding per session plotted separately for red sample trials and green sample trials for each of the matching procedure subjects.

presented in pairs for each subject representing trials when the sample was red and trials when the sample was green. Figure 7 shows the same thing for subjects learning oddity. Here too, with the exception of subject number 15, color preference did not seem to influence responding. Responding on trials when the sample was red was nearly identical to responding when the sample was green.

Figures 8, 9, 10, 11, 12 and 13 show the percentage of correct responding for each subject on each of the four stimulus patterns (RRG, GRR, RGG and GGR). Responding for the matching X straight-correction subjects, Figure 8, reflected the development of a left position preference. On stimulus patterns for which a left response was correct (RRG and GGR), level of correct responding varied initially and then generally increased toward 100 percent. On stimulus patterns which required a right response (GRR and RGG), level of correct responding varied initially and then generally decreased toward 0 percent.

For the oddity X straight-correction subjects and all the modified-correction subjects, Figures 9, 10 and 11, responding reached a high and consistent level of percent correct in fewer sessions on those stimulus patterns for which a left response was correct (RRG and GGR for matching and RGG and GRR for oddity).

The noncorrection subjects, Figures 12 and 13, reached a high asymptote of percent correct responding and reached it first on those stimulus patterns which were 'favored' by their initial position preference. If a subject had a left position preference, then those stimulus patterns for which left was the correct response ('favored' patterns: RRG and GGR for matching and RGG and GRR for oddity) were responded to correctly. Those patterns on which a right response was correct (RGG and GRR for matching and RRG and GGR for oddity) were responded to incorrectly. As long as the position preference was
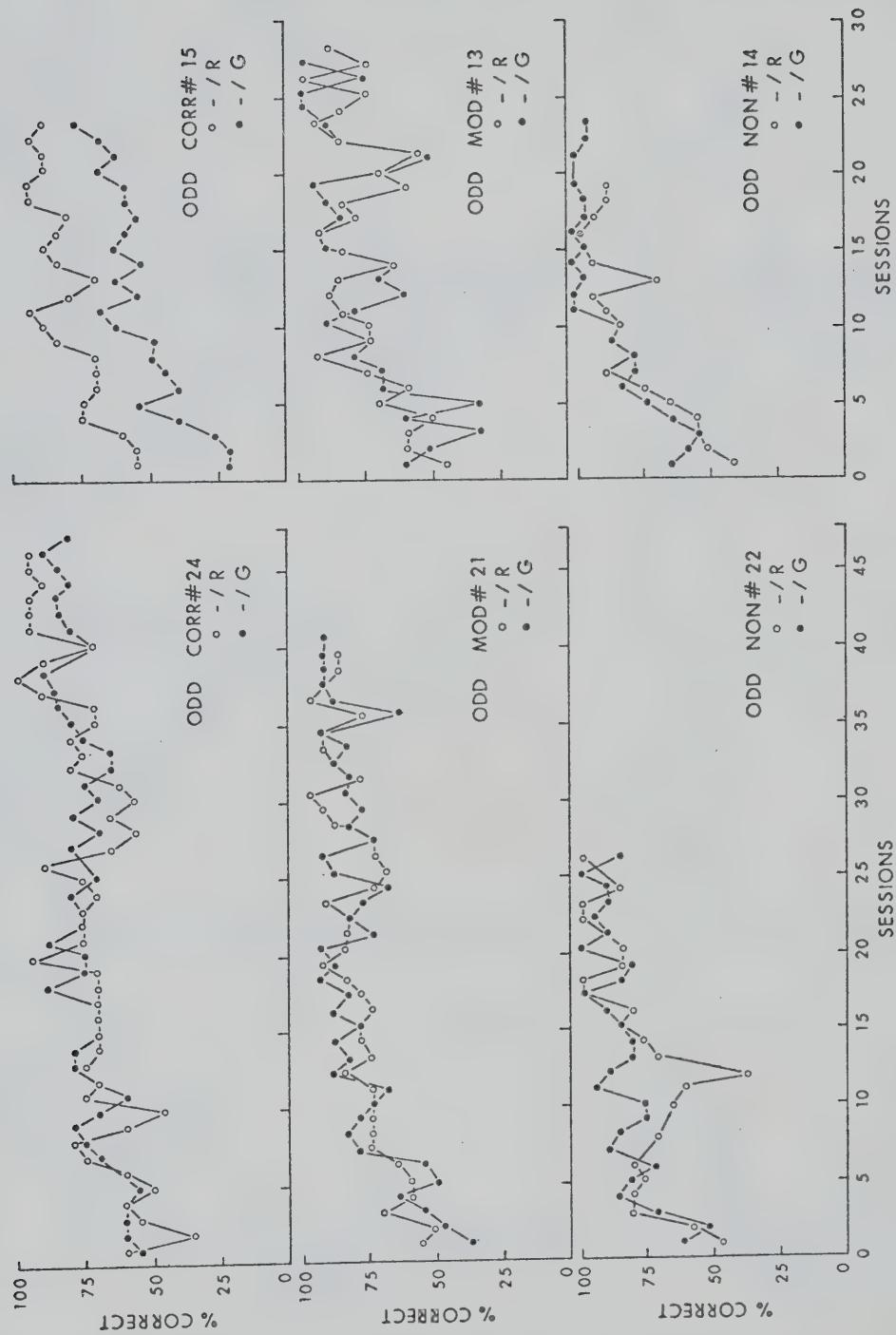
Figure 7. Percent correct responding per session plotted separately for red sample trials and green sample trials for each of the oddity procedure subjects.
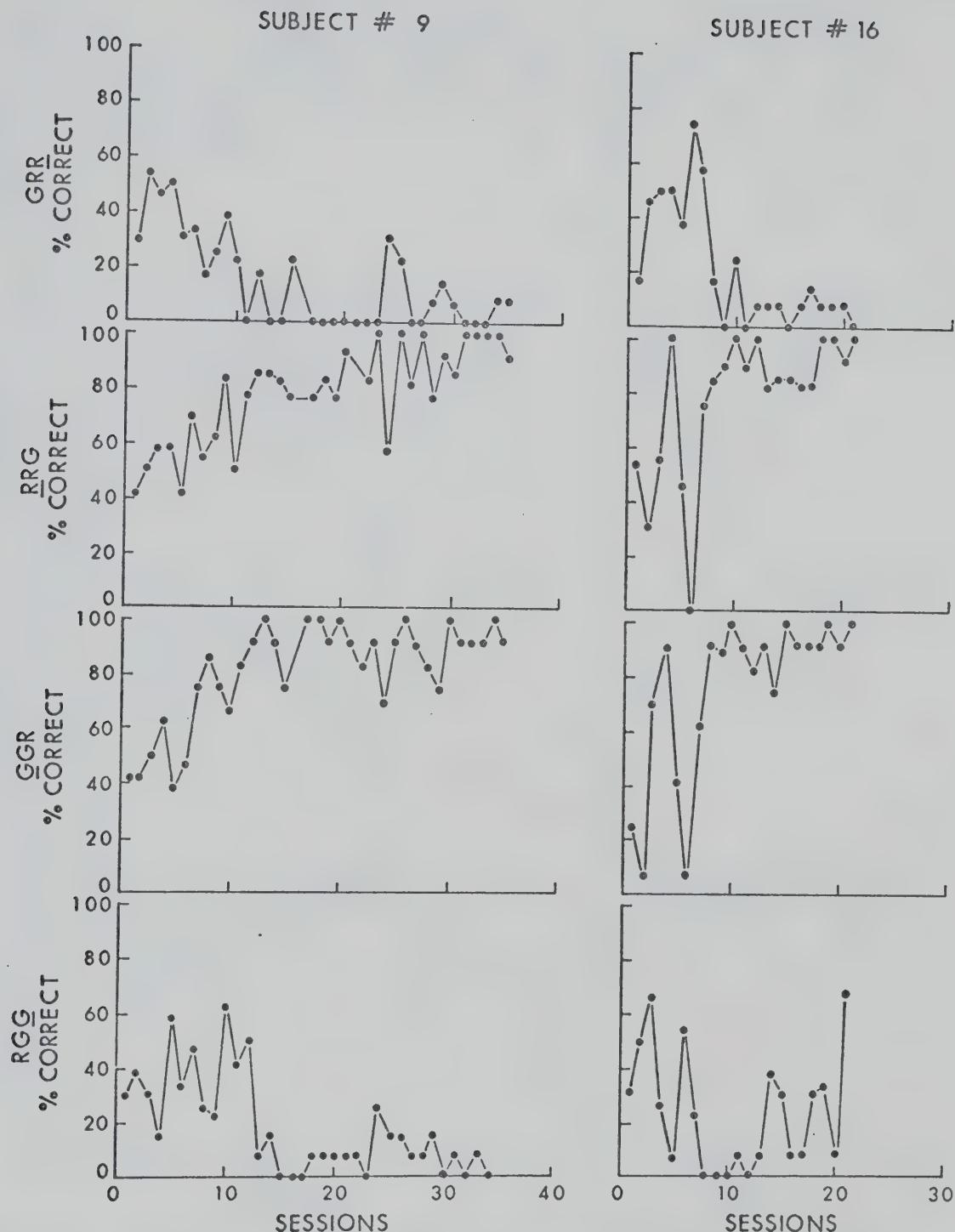
Figure 8. Percent correct responding over sessions on each of the stimulus patterns for the two matching X straight-correction procedure subjects.
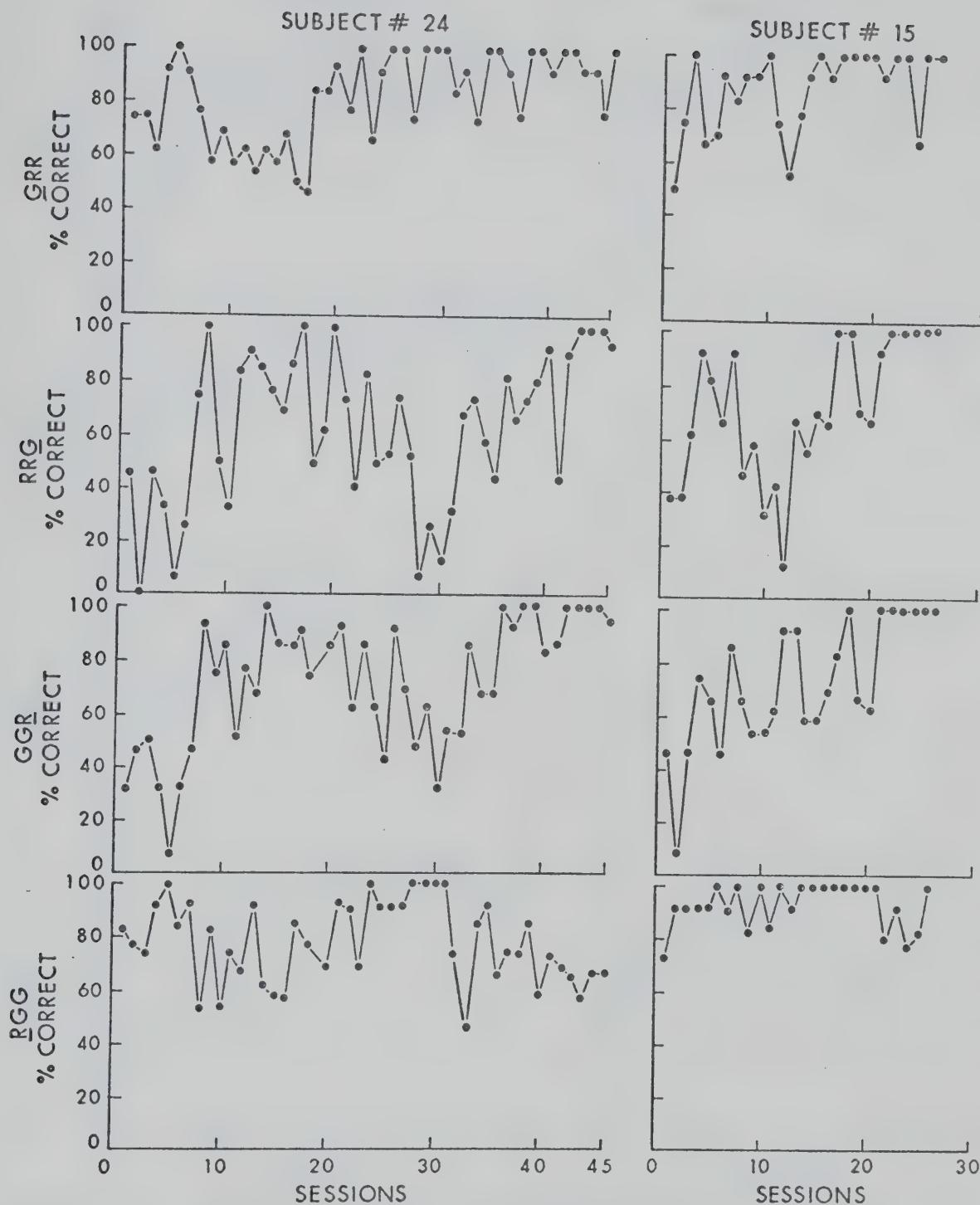
Figure 9. Percent correct responding over sessions on each
of the stimulus patterns for the two oddity X
straight-correction procedure subjects.
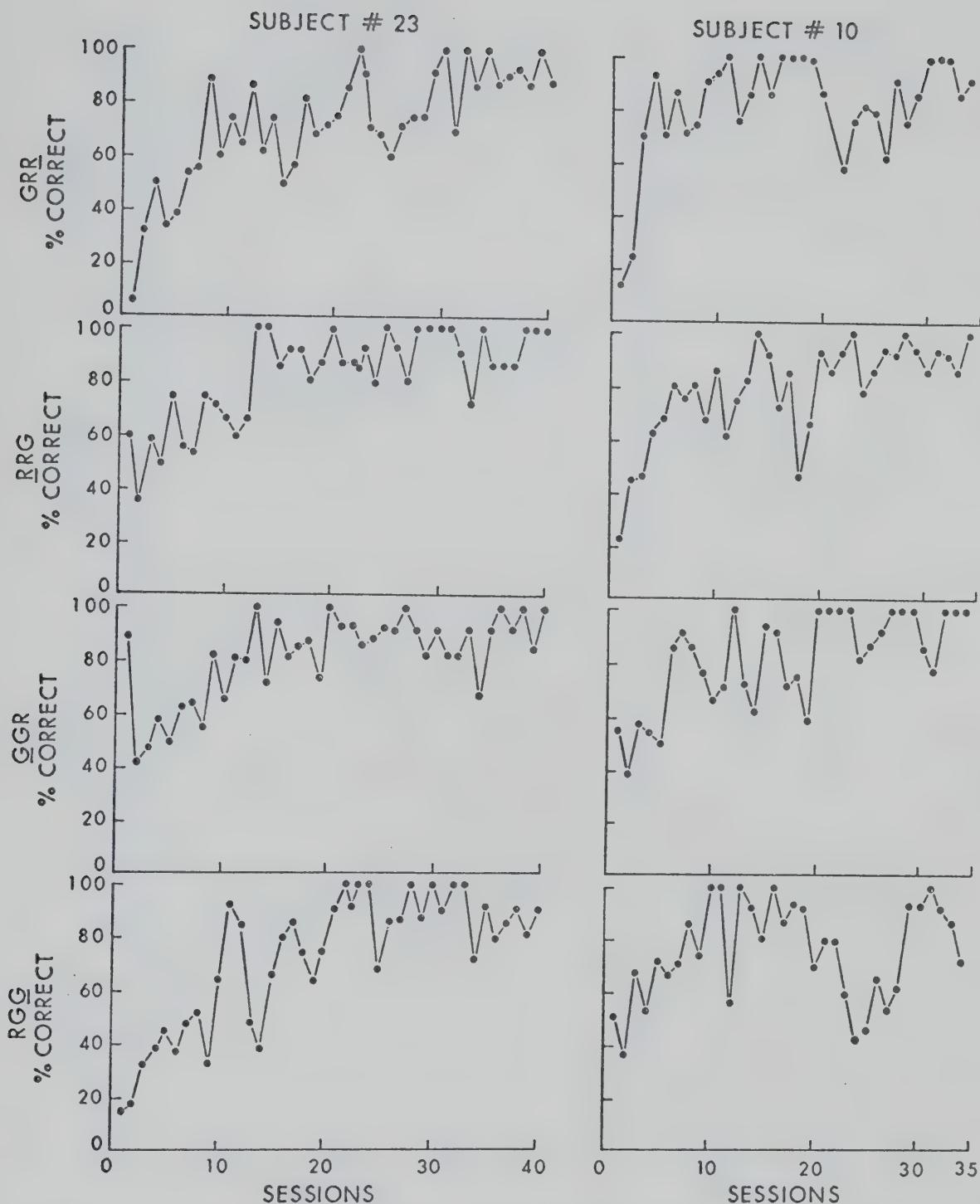
Figure 10. Percent correct responding over sessions on each of the stimulus patterns for the two matching X modified-correction procedure subjects.
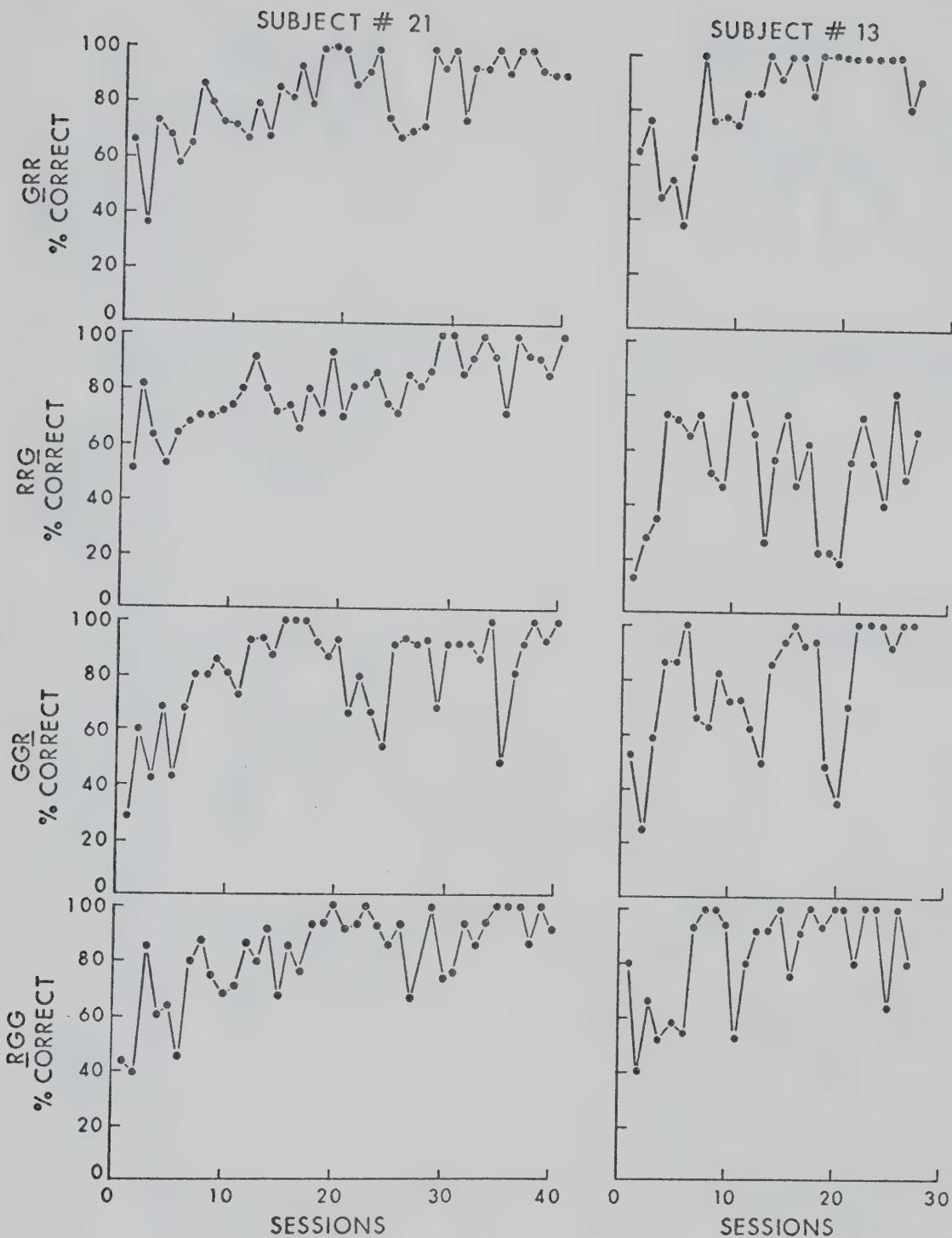
Figure 11. Percent correct responding over sessions on each of the stimulus patterns for the two oddity X modified correction procedure subjects.
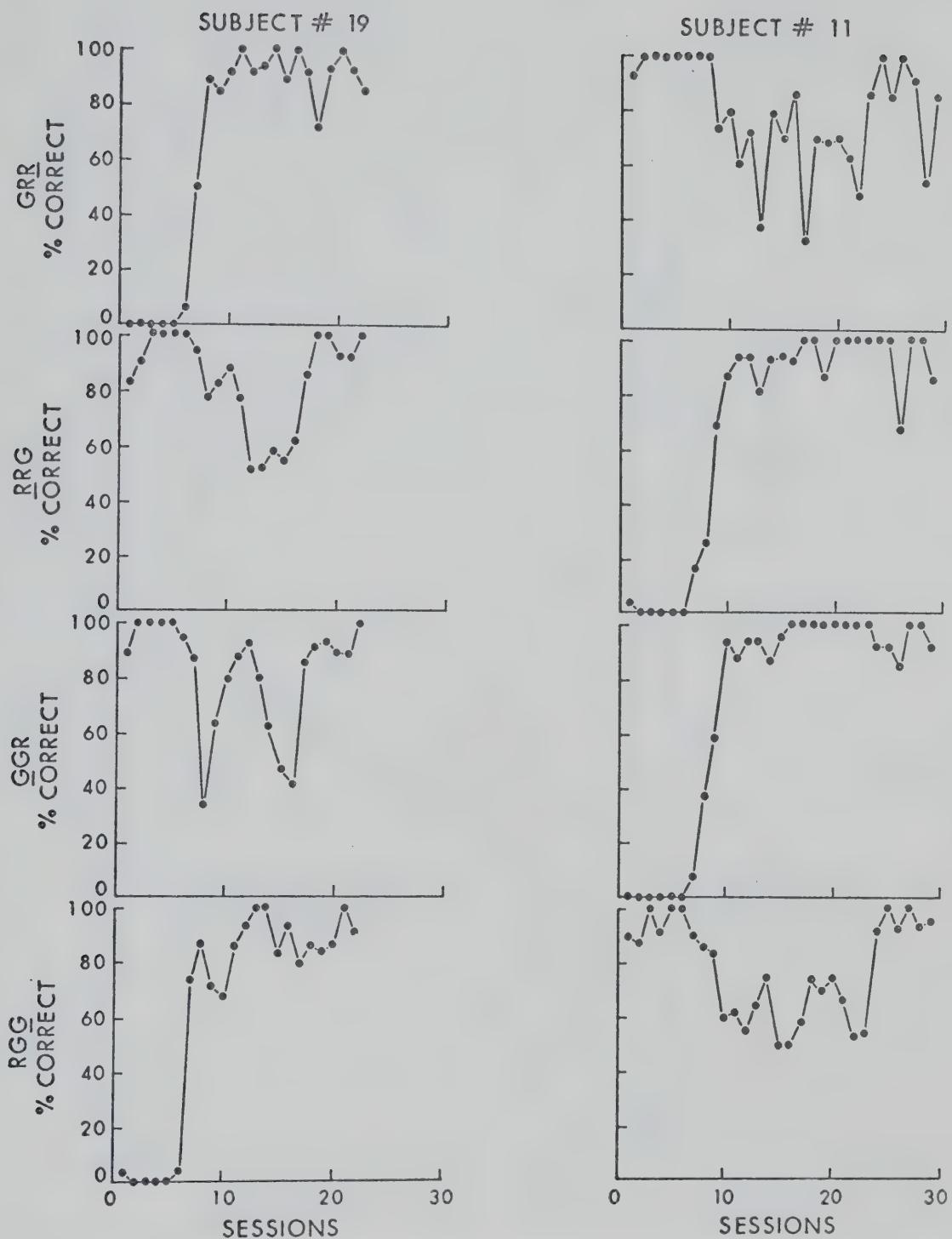
Figure 12.   Percent correct responding over sessions on each
              of the stimulus patterns for the two matching X
              noncorrection procedure subjects.
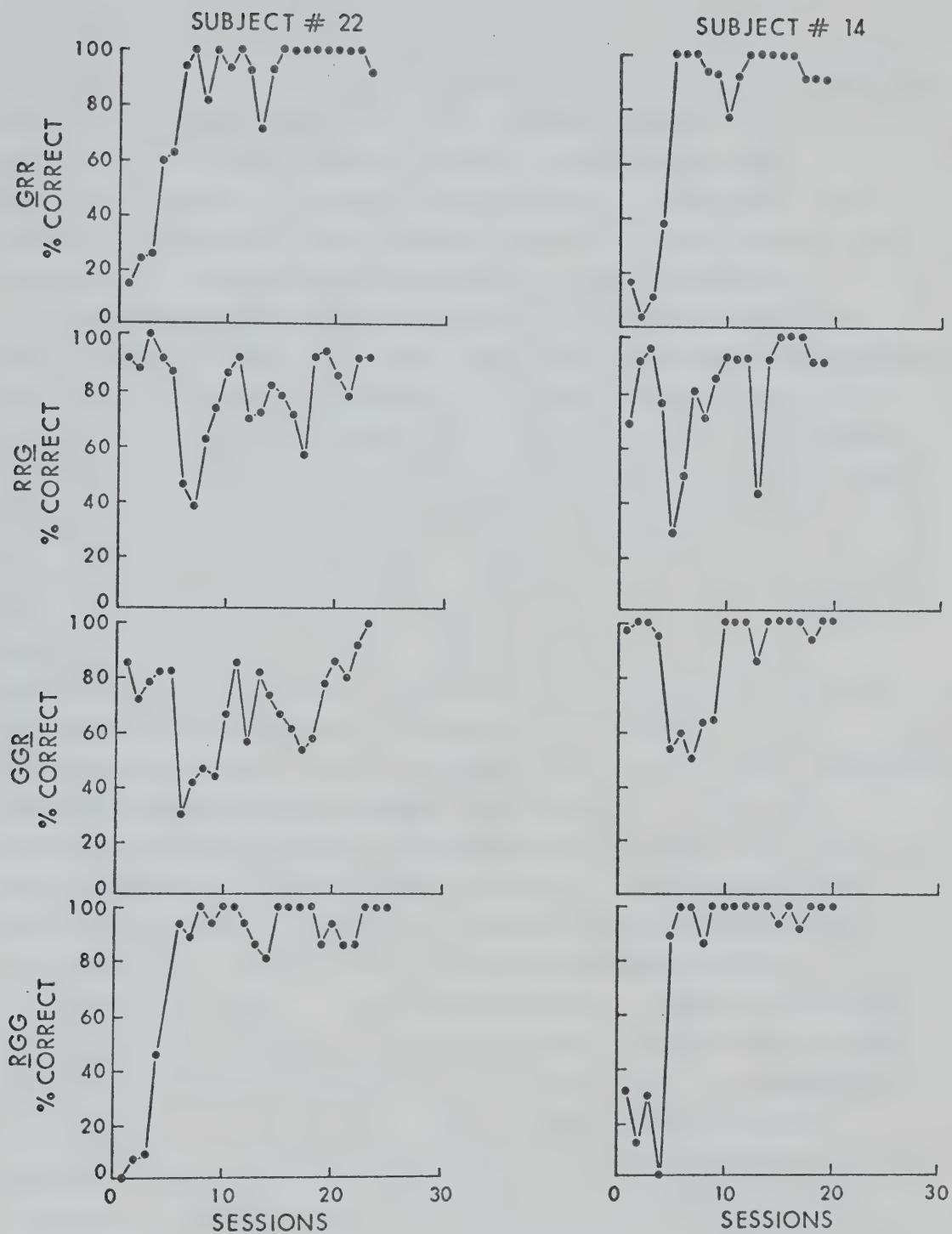
Figure 13.   Percent correct responding over sessions on
              each of the stimulus patterns for the two
              oddity X noncorrection procedure subjects.

maintained the subjects responded at the 100 percent correct level on the two favored patterns and at the 0 percent correct level on the other two patterns. As the preference became less marked responding to the favored patterns did not remain at 100 percent correct but decreased to nearly chance level before returning to criterion level. Correct responding to the other two patterns increased to a higher level than the final level achieved on the patterns favored by the preference.

Responding to the different stimulus patterns is summarized in Table 8. The means and standard deviations of percent correct responding to each pattern were grouped according to whether a right or a left response was correct. Values for each subject were obtained from sessions which came after a double criterion was met. The criterion was defined as moderation of strong initial position preferences and responding above the 90 percent correct level on at least two of the four stimulus patterns. The oddity X straight-correction and all of the modified-correction subjects first solved those patterns on which a left response was correct (RRG and GGR for matching and RGG and GRR for oddity). That is, average percent correct responding was higher for the two patterns on which a left response was correct than for the patterns requiring a right response (straight-correction: $t = 2.97$, $p < .05$; modified-correction: $t = 4.14$, $p < .001$). The variability of percent correct responding was lower on these patterns which were solved first (straight-correction: $t = -3.75$, $p < .01$; modified-correction: $t = -2.72$, $p < .02$). The noncorrection subjects first solved those stimulus patterns for which a correct response was opposite to the strong initial preferences. The average percent correct was lower to the preferred and correct side ($t = 6.32$, $p < .001$) and the variability was higher ($t = 9.13$, $p < .001$).

In an effort to determine more precisely how

Table 8

Mean and standard deviation of percent correct
responding to different stimulus patterns during
final sessions averaged within each correction procedure

	Patterns on which left side is correct m/s – $\overline{R}$RG & $\overline{G}$GR odd – $\overline{R}$GG & $\overline{G}$RR		Patterns on which right side is correct m/s – R$\overline{G}$G & G$\overline{R}$R odd – RR$\overline{G}$ & GG$\overline{R}$	
Corr Proc	$\overline{X}$	σ	$\overline{X}$	σ
St. (odd gp only)	86	13	75	22
Mod. (m/s & odd)	89	11	82	15
Non* (m/s & odd)	77	18	94	7.5

* Substitute 'preferred' and 'nonpreferred' sides
  for 'left' and 'right' sides respectively in column
  headings for this group. Preferred side is left
  for one subject and right for the other three.

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acquisition proceeded or whether different procedures affected acquisition, several more detailed computer analyses were made of the behavioral records. A multiple regression analysis involving groups of several hundred consecutive trials over blocks of sessions was run to look for significant predictors of response on particular trials. There was no evidence that response on a particular trial was a simple function of responses on previous trials.

Another extensive computer analysis involved the grouping of trials within each session on the basis of which key the response was made on. Each group of trials was examined to see what features of the stimulus patterns of color and position they may have had in common. The only common stimulus feature evident within the groups of trials was the position of the comparison colors. This information reflected the position preference data already reported.

A third analysis involved a straightforward tally of responses in different response categories. These categories included runs and alternations of responding to position, incorrect responses during different segments of a session, shifting and not shifting of response position after a reinforced response, and shifting and not shifting of response position after a nonreinforced response. It was not possible to analyze all of the data in this way due to inadequate recording equipment. From the data available this third analysis provided some information as to what those subjects who did not have strong position preferences were doing during initial sessions. Some of this category data is presented in Tables 9 and 10. Table 9 shows how the matching X straight-correction subjects were responding during the initial (first 10 percent) sessions. Looking at the matching data, it is seen that subject number 9 initially responded to that position just reinforced, but other than this there was no predominant category for either subject

Table 9

Sample of Sessional Response Patterns
for Straight-Correction Procedure Subjects*

Session		Position		Pos Pref		Pos Resp after Reinf	
		Alt	Rep	Left	Right	Opp	Same
M/S S#16	1	57	42	54	46	38	62
	2	36	64	29	71	43	57
	3	40	60	39	61	53	47
	4	35	65	78	22	60	40
	5	63	37	52	48	33	67
	6	25	75	18	82	48	52
	7	49	51	60	40	43	57
	8	16	84	90	10	43	57
M/S S#9	1	59	39	52	48	22	78
	2	52	48	51	49	27	73
	3	51	49	58	42	39	61
	4	39	61	64	36	57	43
	5	50	50	48	52	57	43
	6	52	48	61	39	64	36
	7	35	65	66	34	63	37
	8	37	63	74	26	59	41
	9	41	59	74	26	53	47
	10**						
	11	29	71	80	20	52	48
	12	31	69	78	22	61	39
	13	21	79	90	10	47	53
	14	12	88	94	6	55	45
ODD S#15	1	45	55	60	40	65	35
	2	33	67	82	18	43	57
	3	51	49	72	28	45	55
ODD S#24	1	47	53	68	32	51	49
	2	29	71	75	25	47	53
	3	47	53	58	42	63	37
	4	35	65	80	20	51	49
	5	8	92	96	4	52	48

* Data represent percent of approximately 50 responses.
  Data for the matching subjects are for those initial
  sessions prior to the final position preference; for
  the oddity subjects, the initial 10 percent sessions.

** Data missing.

Table 10

Number of Response Alternations and Repetitions
During First 10 Percent of Sessions*

Subject	Session	Alternation	Repetition
M/S Mod #10	1	56	113
	2	40	53
	3	52	58
M/S Mod #23	1	28	121
	2	44	121
	3	44	67
	4	44	39
Odd Mod #13	1	47	44
	2**		
	3	50	70
Odd Mod #21	1	39	68
	2	43	55
	3	41	40
	4	32	35

* While number of reinforcements per session was
50, it was possible to have a great many more
trials per session than reinforcements since
an incorrect response terminated a trial without
a reinforcement.

** Data missing.

until the development of position preferences.   Subject
number 9 showed a gradual but consistent development of the
terminal left position preference while subject number 16
switched from left to right to no position preference
before finally settling into the left preference.   This
was evident on the position preference curves too, in
Figure 4.   The oddity X straight-correction data show
only the presence of moderate initial position preferences.

Table 10 shows position alternation and repetition
during initial sessions for the subjects on the modified-
correction procedure.   It is seen that the matching X
modified-correction subjects began with a preponderance of
repetition responses in the first one or two sessions and
then established somewhat of a balance between alternations
and repetitions.   On the other hand, the oddity X
modified-correction subjects did not show such a dominance
of response repetition initially.   No other trends were
evident in this analysis.

DISCUSSION

The purpose of this research has been to delineate
the acquisition differences between matching-to-sample
and oddity-to-sample. The problem has been one of
determining whether these differences were inherent to
the learning process, or were artifacts of the training
procedures. Systematic response tendencies to different
stimulus configurations during presolution were studied to
see whether the presolution behavior during learning
somehow intrinsically favored the acquisition of matching
over oddity. It is known that variations in preliminary
training, correction procedure and criterion of solution
can result in diverse effects on performance. Preliminary
training was designed to minimize the possibility of any
differential effects on matching and oddity behavior.
This was done by initially shaping the key peck response
on a single key. Only after the response was learned
were the three keys presented simultaneously. Responding
on the center one of the three keys was never reinforced
with food, and consequently never extinguished. Learning
criteria were chosen to maximize the possibilities for
any learning differences to become apparent. Various
correction procedures were used to determine whether they
had any selective effects on matching or oddity learning.
Before discussing the matching-oddity differences
evident in presolution behavior let us examine the
contribution of correction procedure to performance
difference.

Correction Procedure
With the exception of the matching X straight-
correction group, all subjects followed a similar course
in their learning behavior (Figure 3). The noncorrection
subjects reached criterion level performance in the fewest
sessions (Table 4). Their performance corresponds to

data reported by Cumming and Berryman (1965) who found
that those subjects which adopted strong initial position
preferences reached criterion sooner than subjects which
responded according to some other system. For Cumming
and Berryman this meant that their matching subjects
reached criterion sooner than their oddity subjects, since
under their noncorrection procedure the matching subjects
exhibited stronger initial preferences than the oddity
subjects. As seen in Figure 4, both the matching and
oddity noncorrection subjects in the present study
showed very much stronger initial position preference
responding than the straight- and modified-correction
subjects.

Analysis of position preference (Figure 4 and Tables
6 and 7) revealed other differences associated with
correction procedure. The responding of the straight-
correction subjects was characterized by high variability,
moderate initial preference for those subjects learning
oddity, and development of a complete preference in lieu
of the high asymptote solution for those subjects learning
matching. The modified-correction subjects showed very
little variability or preference. The noncorrection
subjects showed low variability but, as previously
mentioned, strong initial preference. These differences
in positional responding according to correction
procedure can be explained, at least in part, by looking at
the individual stimulus-response sequences which occurred.

Straight-correction. The straight-correction
subjects did not make consistent use of position preference
initially, although they could have obtained 50 percent
reinforcement on the first response by such a preference.
A more detailed sessional analysis of the early matching X
straight-correction data (Table 9) indicated that instead
of response patterns consistently based on position
preference there was variation from session to session in
the response patterns used. All of the other patterns

also resulted in approximately 50 percent reinforcement.
This variation in response patterns could help to explain
the high session to session variability of the positional
response data in this condition.   One of the more consistent
of these other response patterns was responding to the
side on which a response was reinforced on the previous
trial (3rd column, Table 9).   This pattern of responding
meant there was a somewhat higher frequency of responding
to the odd stimulus since the stimulus which was on the
same side as the previous correct and reinforced stimulus
was odd 65 percent of the time.   In the case of matching,
such a response would be incorrect.   This tendency of
the matching subjects to respond odd could explain why they
did not reach the solution criterion, but instead
developed a position preference.

Ginsburg (1957) suggested that on a straight-correction
procedure the incorrect response might be getting reinforced
by its close association in time to the correct response.
Alternatively, the ease of making an incorrect response
might make it negligible in terms of energy output, and
hence persistent over time.   Both of these possibilities
could have led to the behavior which the subjects on the
matching X straight-correction condition eventually
exhibited.   If responses on both keys were being
reinforced, and the wrong response was being made almost
automatically, then the development of a position
preference would not be surprising.   It has been shown
that the probability of an animal resorting to a position
preference during discrimination training is high even when
the discriminative cues are quite distince (Harlow, 1959;
Irwin, 1958; Krechevsky, 1932).   And in the case described
here for the matching X straight-correction condition the
discriminative cues were not even very distinct.

One reason why the oddity X straight-correction
subjects did not resort to a final position preference
might be that instead of switching from one response

pattern to another they developed moderate position preferences. Unlike some of the other response patterns available, position preference did not differentially favor matching or oddity responding. While it is true, as with the matching X straight-correction procedure subjects, that incorrect responses may have been getting reinforced, still oddity behavior eventually predominated and reached criterion. One subject showed a slight tendency to respond to the side opposite that which was reinforced (subject number 15, Table 9). However the moderate degree of position preference accounted for his tendency: on one trial the subject switched from his preferred side to the correct side for reinforcement, and on the succeeding trial switched back to his preferred side.

Modified-correction. A very strong color or position preference for a subject in a modified-correction condition would mean that one trial would be repeatedly presented, and the program and the subject would be 'stuck' at that point. At least program advancement would be very slow, and consequently reinforcements few. For example, if the subject had a strong left position preference the program would never advance beyond the first trial which required a right response. The subject would respond left, the trial would terminate and after the intertrial interval the same trial would be repeated. But if a left response was incorrect a right response next would be guaranteed correct. The subject would have to eventually respond right in order to get another type of trial. Position preference would result in close to 0 percent reinforcement while responding to almost any other cue would increase the probability of reinforcement.

Alternation of position responses would yield approximately 75 percent reinforcement. (Every trial on which an incorrect response was made would be followed by a correct response on the next trial since it would be the same stimulus pattern. Half of the total number of responses then would be contributing 25 percent reinforcement

while the other half of the responses would be correct,
contributing 50 percent reinforcement.)   A strong color
preference would result in 50 percent reinforcement.
Two modified-correction procedure subjects, both in the
matching condition, had to be replaced for responding to
the same position.   They got 'stuck' responding on one side
until they finally stopped responding altogether early in
training.   Table 10 gives a more detailed picture of how
the other subjects were responding.   The record of response
alternations and repetitions shows that the responding
of the successful matching X modified-correction subjects
was characterized by repetitive positional responding,
wheras the oddity X modified-correction subjects showed
responses fairly evenly distributed between repetition and
alternation of position.   It appears that there was a
tendency for these successful matching X modified-
correction subjects to respond initially in accordance with
a position preference.

Why did the oddity X modified-correction subjects not
show this tendency as well?   Since a position preference
is not evident in the data in Figure 4, it would seem that
what appeared to be a position preference in the data in
Table 10 was actually the manifestation of another
response tendency, a tendency to respond to a stimulus
which was different, novel, or odd.   This would not
necessarily mean that the subjects were operating on an
oddity-to-sample principle.   The subject could have
ignored the relationship between the sample key and the
comparison keys and responded on the one key in three which
was different.   Even more simply, when the comparison keys
came on that key which was a different color could have
attracted the subjects' attention.   The key which was
the same color would go unnoticed.   In a modified-correction
procedure a tendency to respond to the odd or novel stimulus
would result in reinforcement on an oddity condition and
nonreinforcement on a matching condition.   Thus, the

failure of two matching X modified-correction subjects
to condition at all could be accounted for by saying that
their tendency to respond to the odd stimulus resulted in
trial repetition and response repetition to such an
extent that these particular subjects stopped responding.
A tendency to respond to the odd stimulus in the modified-
correction procedure could also explain the higher
initial level of percent correct responding for the subjects
on the oddity condition (Table 5).   The low session to
session variability of the positional response data
(Table 6) can be attributed to these modified-correction
procedure subjects being limited in their stimulus-
response sequences to the tendency to respond odd.

Noncorrection.   In the noncorrection procedure,
as in the straight-correction procedure, a subject could
obtain 50 percent reinforcement by adopting a position
preference.   And in contrast to the modified-correction
procedure, the termination of a trial due to an incorrect
response served to advance the program to the next
programmed trial.   In this case the subjects on both
the matching and the oddity procedures immediately
adopted a complete position preference, unlike the
subjects in the straight- and modified-correction
procedures.   Why these subjects did adopt such strong
preferences so quickly and the straight-correction
subjects did not must be related to the correction
procedure, and to the fact that in the noncorrection
procedure an incorrect response meant so much more in
terms of time and effort.   The implications of these
strong initial preferences will be discussed in the
next section.

Stimulus-Response Sequences during Presolution
When the position preference data, Figure 4 and Table
7, were interpreted in conjunction with the data of
percent correct responding to each of the four stimulus

patterns, Figures 8 - 13 and Table 8, another response tendency became evident.   On the noncorrection procedure (Figures 12 and 13) responding proceeded in either one of two ways according to the subjects' initial position preferences.   Those two patterns for which a preferred position response was incorrect (GRR and RGG for subjects number 19, 22 and 14 and RRG and GGR for subject number 11) were solved sooner than the two patterns for which a preferred position response was correct (favored patterns: RRG and GGR for subjects number 19, 22 and 14, and GRR and RGG for subject number 11).

Responding on the two patterns which were solved first began at 0 percent correct, because of the position preference, and then increased abruptly to nearly 100 percent correct.   The change in percent correct response level occurred in the same session for both of these stimulus patterns.   The simultaneity of the changes would suggest that the subjects were responding to some common feature of the two stimulus patterns, the obvious one being the position of the stimulus which was correct.

Responding on the other two stimulus patterns, those which were favored by position preference, began at over 90 percent correct, decreased to chance level and then generally increased to near 90 to 100 percent correct.

The modified-correction procedure subjects and the oddity X straight-correction subjects first solved those two stimulus patterns for which a left response was correct.   Unlike the noncorrection subjects, these subjects had only a very moderate initial position preference, for the left in all cases.   In contrast to the noncorrection subjects which solved the two nonfavored stimulus patterns first, the modified- and straight-correction subjects solved the two favored patterns first.

It is interesting that responding on patterns favored by strong initial position preferences in noncorrection did not remain at the 90 to 100 percent correct level when the

position preference disappeared. It would appear
that learning was proceeding in a noncontinuous fashion
on these two patterns. Learning seemed continuous on
the other two patterns on the noncorrection procedure
and on all patterns when using the modified- and straight-
correction procedures. If the subjects were learning
to respond on the basis of a matching- or oddity-to-sample
conditional discrimination principle one would not expect
learning to proceed differentially on different stimulus
patterns. The presence of these stimulus pattern
differences suggested that the subjects might have been
learning the correct position response to each particular
pattern. Rather than the intended conditional discrimination
the subjects approached it as a successive discrimination
task.

Matching versus Oddity

Berryman, et al. (1965) and Ginsburg (1957) have made
conflicting claims, each on the basis of his data, about
the relative difficulty of learning a matching or an oddity
problem. The claims in both cases were based upon two
factors: speed of acquisition and initial level of percent
correct responding. Thus far we have seen that correction
procedure is quite a relevant variable where these two
factors are concerned. Let us now look for evidence of
matching-oddity differences which are independent of
correction procedure.

Considering speed of acquisition first, the matching
subjects on a straight-correction procedure never reached
the high asymptotic response level, or solution criterion
of their oddity counterparts. Hence it could be said that
the oddity subjects reached solution criterion earlier than
the matching subjects. The spread of effect of the
reinforcer to the incorrect response, plus the effort-
lessness of making an incorrect response may explain why the

matching X straight-correction subjects did not reach the
solution criterion but developed a position preference.
Perhaps requiring a more complex response would preclude
the development of this position behavior and permit the
subject to more readily reach the solution criterion.
For example, a ratio schedule of reinforcement would not
only mean that the response itself required more work,
but also that the eventual reinforcement would be more
remote from the incorrect response.   Within the other
correction procedures, subjects on the oddity problem
required only slightly fewer sessions to reach solution
criterion than subjects on matching (Table 4).

　　　Initial level of percent correct responding was the
other difference between matching and oddity performance
found in the literature.   The present data show that
subjects learning oddity began at a higher level than
subjects learning matching (Table 5).   Cumming and Berryman
(1965) and Ginsburg (1957) both reported this difference
also.   Unlike the Cumming and Berryman data however, in
the present study this matching-oddity difference was
very small for the noncorrection subjects.   Initial levels,
and therefore rates, are nearly the same for the noncorrection
procedure subjects.   For the subjects in the modified-
and straight-correction procedures, because oddity
responding began at a higher level of percent correct
than matching and took about the same amount of time to
reach criterion (Table 4), the rate of acquisition of
oddity was slower.   The fact that the rates of acquisition
were not equal suggests that perhaps the matching and
oddity problems were not being learned in the same way.

　　　The fact that responding to oddity began at a
higher level of percent correct could mean that the subjects
approached the task with a tendency to respond according
to an oddity principle.   Such an inherent tendency to

respond odd should have given sufficient advantage to the
subjects on oddity to enable them to reach solution
criterion sooner than the subjects on matching.   However,
this was not the case for any condition (Table 4).
Considering the performance of the subjects in the matching
X straight-correction condition, an initial tendency
to respond odd may have been another reason why these
subjects did not learn the matching task in the prescribed
way while the oddity straight-correction subjects did.
As described earlier, the incorrect response was being
reinforced, and the effort in making an incorrect response
was negligible.   In addition the subject had a stronger
tendency to respond to the odd stimulus than to the
matching stimulus.

Reinforcement of oddity behavior in both the matching
and the oddity conditions may result when a subject
is trained on a straight-correction procedure.   If
the subject pecks the incorrect comparison key color
and then switches his response to the other comparison
key, the correct one, he will be reinforced for an
oddity sequence of responding.   In a matching condition
the response sequence would be responding to red (sample),
then green (incorrect comparison), then red (correct
comparison).   In an oddity condition the response
sequence would be slightly different since the first
two responses made would be to the same color.   That
is, the subjects would respond red (sample), then red
(incorrect comparison), then green (correct comparison).
In both conditions the comparison key responses constitute
an oddity sequence which is followed by reinforcement.

Comparing the data from the noncorrection procedure
to that from the modified-correction, it would seem
that those subjects which employed a strong position
habit initially, namely the noncorrection subjects,

learned the task faster. The matching X and oddity X noncorrection subjects began responding at nearly the same level of percent correct and took the same amount of time to reach criterion (Table 4). Rates of acquisition for both matching and oddity subjects on a noncorrection procedure were equal. An initial position preference served as a response cue which maintained behavior during early acquisition. When responding was systematic in this way there was no matching - oddity difference.

In the case where no initial preference was evident, the initial level varied for matching and oddity subjects and rate was lower for matching. The question of why only one of the correction procedures (noncorrection) fostered initial position preference, or why the other two correction procedures fostered some other way of responding initially, is answered by comparing what happens in the stimulus-response sequencing if a position preference is employed. As noted earlier, for the modified- and straight-correction groups a position preference meant the program would not advance. Why did not these subjects adopt some other consistent and simple mode of responding initially? This depends upon what modes were available to the subject. Color or brightness would seem an obvious cue, but perhaps not to budgerigars since the data show that the birds did not respond differentially to it. Or they could have used a position alternation mode of responding (Bolles, 1967; Mowrer, 1960; Montgomery, 1952a). Instead, oddity seemed to be the mode of responding used. However, what appeared to be oddity may also be described as response to novelty (Hinde, 1966; Montgomery, 1951, 1952b) or perhaps even due to the physical aspects of the apparatus. The subjects had been conditioned to peck

a single central key, and then were conditioned to peck
only the side keys.   During side key conditioning only
one key was on at a time and reinforcement was delivered
equally (50 percent of the time) to each side and to
each color.   When the final matching or oddity procedure
was instituted, it would seem reasonable that the subject
would peck the first key that came to its attention.
When the center key came on it pecked it.   Then, when
the comparison keys came on, that key which was of a
different color would likely have been the one to have
caught the subject's attention, and hence to have been
pecked.   Perhaps this response tendency could have been
forestalled by changing the stimulus panel so that there
was more separation between the stimulus keys.   This would
require a greater change in the subjects' position when
changing from a response on the sample key to a response on
the comparison key, and also when comparing the two
comparison keys.   The subjects might pay more attention
to the stimuli, and to the task.   Such a change might also
make the matching comparison stand out more distinctly
from the sample so that it could compete better with the
odd comparison for the subjects' attention.

On the modified-correction procedure the rate of
acquisition for the oddity subjects was lower than the rate
for the matching subjects.   Responding according to
the correct cue at the outset of the learning task
resulted in a lower rate of acquisition - learning was
not accelerated.   Perhaps by beginning closer to solution
the subject skipped some aspect of the learning process.
He was therefore handicapped in the completion of the
learning process and had a slower rate of acquisition.
This agrees with the evidence discussed earlier concerning
the noncorrection procedure.   The subjects on noncorrection
were slower to solve the problem for the stimulus

patterns which were favored by initial position preferences. The fact that the initial mode of responding was correct did not accelerate the learning of these stimulus patterns, but apparently retarded it with respect to the other stimulus patterns. Responding to the correct cue at the outset of acquisition did not facilitate learning.

There seemed to be no matching-oddity differences which were independent of correction procedure. In the straight- and modified-correction procedures initial levels of percent correct responding varied, probably as a result of a tendency to respond to the odd or novel stimulus. Instead of this tendency in the noncorrection group the subjects responded positionally. In the straight-correction procedure the final asymptote varied for the matching and the oddity subjects due to the matching subjects resorting to a position preference as a means of solution. In the modified- and noncorrection procedures the final asymptote was the same for the matching and the oddity subjects. Perhaps the reason why there were no matching-oddity differences was because the subjects were learning a successive discrimination involving different stimulus patterns, instead of matching and oddity conditional discriminations.

Beyond the Stimulus and the Response

Discriminative behavior can be dichotomized into successive and simultaneous (Lovejoy, 1968). In a successive discrimination procedure only one of two or more stimulus values is presented on a given trial and different responses are appropriate for each stimulus value. It is Lovejoy's contention that in a successive discrimination the subject learns the appropriate response, "response selects", on each trial. Response 'A' becomes associated with stimulus 'A' and response 'B' with stimulus 'B'. On the other hand, in a simultaneous discrimination

two or more stimulus values are presented together on a
trial and a single response is appropriate to only one of
them.   Lovejoy suggests that here the subject learns to
choose the stimulus to which a response will be made,
or "stimulus selects".   If 'A' is the correct stimulus
the subject will learn to respond to 'A' whenever it
appears regardless of its position or the presence of
other stimuli in combination with it.   Lovejoy made an
extensive survey of behavioral records from research on
this topic, looking for evidence of stimulus selection or
response selection in simultaneous and successive
discrimination procedures.   He found that the literature
supported his distinctions of response selection on
successive discriminations and stimulus selection on
simultaneous discriminations.   The present study was
designed as a simultaneous discrimination, but it is
possible to think of the four different stimulus patterns
used here as four stimulus patterns in a successive
discrimination.   The data should tell if the subjects were
stimulus selecting or response selecting.

Cumming, et al. (1965) investigated the possibility
that subjects treated a simultaneous discrimination as
successive in their study of the generalization of
simultaneous matching to a novel stimulus.   They used a
three-color matching procedure as described above, on
page 5, rather than the two-color procedure used in the
present study.   After the simultaneous matching task had
been learned, a new color was substituted for one of the
original colors.   Matching was disrupted only on those
trials in which the new color was the one to be matched.
On trials in which the new color was the nonmatching
comparison, matching behavior was not disrupted.   This
indicates that the subjects were not responding to each of
the stimulus patterns separately as though it was a
successive discrimination.   If they were, then behavior
would have been disrupted on all trials which used the new

color.   Berryman, et al. (1965) made a similar substitution
in their study of the generalization of oddity.   In
all cases the new color was on a key which required a
response, either the sample or one of the comparisons.
Whether the subjects were learning a simultaneous or a
successive discrimination therefore could not be determined
from that study.

The present study did not include a test by stimulus
substitution of whether subjects were responding to
successively presented stimulus patterns instead of
stimulus selecting according to the relational principles
of matching and oddity.   However, the data showed
consistent stimulus pattern order-of-solution effects,
which suggested that the subjects were responding to a
combination of stimulus pattern and positional cues.
The data from the noncorrection condition showed that
these subjects were responding to positional cues in
terms of position preferences.   The data from the modified-
and straight-correction procedures showed stimulus pattern
order-of-solution by position without this preference
behavior interaction.   Responding was controlled more
by separate stimulus patterns than by a simultaneous
matching or oddity principle.   It may be that the subjects
were working on a successive discrimination rather than
the programmed simultaneous discrimination.

Perhaps something more complex than stimulus-
response connections is involved here.   It could be that
no stereotyped or fixed stimulus-response patterns were
involved, but rather more Tolmanian relationships such as a
subject would develop by means of cognitive evaluation of
his responses and the outcome of the past trials (Tolman,
 Richie & Kalish, 1946).   Apart from consideration of
whether the subject was learning a particular response in
the presence of each different stimulus pattern, or learning
to pick and respond to a particular stimulus, what was the
subject doing?   It seemed to be the case that those subjects

which initially adopted position preferences had an advantage over subjects which did not. Krechevsky (1932) contended that a subject responds according to one, then another and another mode of solution until success is achieved. What seemed to be the case in the present study was that the subject which responded consistently according to only one mode, position, achieved success sooner than subjects who were doing something else, perhaps trying various other hypotheses. Perhaps the systematic nature of the subject's positional responding enabled it to learn what behavior was and was not being reinforced and hence to shift more readily to responding to the correct stimuli.

This data showing that initial position preferences seemed to facilitate learning suggests a two stage learning process, somewhat like Sutherland's (1959). The first stage would involve determining the relevant stimulus dimension. In effect, by responding consistently to one position the subject could be considered to be simply observing the succession of trials, responses being of little importance. By always responding on the same key, the subject would not be interacting with the stimuli to any very great extent, but would be receiving reinforcement when the correct response was on the preferred side. The second stage, formation of stimulus-response associations, would evolve either after the position preference was discarded and responses were varying from trial to trial, or when the strength of responding to the correct cue was greater than the strength of the position preference (Spence, 1951).

CONCLUSIONS

Correction procedure was found to be a statistically significant factor in the learning of a conditional discrimination. Subjects on a noncorrection procedure solved both matching and oddity type conditional discriminations more rapidly than subjects on the other correction procedures. A relevant variable associated with this difference appeared to be position preference. Subjects on the noncorrection procedure adopted strong initial position preferences which were followed by a rapid rise to criterion level. Although the matching X noncorrection condition subjects showed a stronger initial preference than the oddity X noncorrection condition subjects, they did not reach criterion in significantly fewer trials. Subjects on the other two correction procedures, straight and modified, showed little initial preference behavior but did respond more in accordance with an oddity principle initially, regardless of whether they were on a matching or oddity procedure. In the modified-correction procedure the subsequent number of sessions to criterion was not less for those subjects working on the oddity problem. That is, rate of acquisition was lower for the oddity subjects. The matching X straight-correction subjects apparently solved the problem in a different way than the other groups. They adopted a position preference, correcting an incorrect response when necessary. Because the effort in making the incorrect responses was negligible they were essentially getting reinforced on every trial. The advantage given by beginning at a higher level of percent correct responding may be the reason why the oddity X straight-correction procedure subjects reached a high level asymptote while the matching X straight-correction procedure subjects did not. In all three correction procedures the matching subjects showed a greater tendency toward position preference than the

oddity subjects.

The strong interaction of matching-oddity differences with correction procedure would suggest that the differences found in previous work were due to procedural variables.

A comparison of responding to individual stimulus patterns revealed that those subjects which employed strong initial position preferences first solved the two stimulus patterns for which the correct position was opposite to their preference.   The subjects with very moderate or no preference all solved first the stimulus patterns for which a left response was correct.

Looking for stimulus-response pairings in behavior during presolution did not reveal any consistent relationships which would indicate 'hypothesis' sampling in the manner described by Krechevsky (1932).   From the evidence on order of solution of the four different stimulus patterns it was concluded that the subjects were probably not learning a simultaneous discrimination based on relationship.   Instead, they were learning a successive discrimination, or learning the appropriate position response to each stimulus pattern.

There is no evidence of intrinsic differences in the learning of a discrimination depending on whether it is based upon a relationship of similarity or of difference.   The difference between learning to choose that which is the same and that which is different represents an artifact of experimental procedures.

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APPENDIX

Budgerigars as Subjects

As an experimental subject the budgerigar has proven
to be quite successful.   Maintenance and space requirements
are minimal, they are easy to condition, and work well for
food reinforcement.   Out of approximately thirty-six
budgerigars with which I have worked only one has failed
to condition.   Three or four birds were run intermittently
on pilot work over a period of two and one half years with
no difficulty.   Death rate was low and no birds have ever
died during the course of an experiment.   That is, death
has only occurred before any conditioning took place,
soon after coming into the laboratory, or after a study was
concluded and the birds were simply being maintained on
ad lib for long periods.   Two birds had difficulty in
conditioning because they walked on the response keys.
However, a simple wire mesh shield over the keys through
which the birds had to reach their heads in order to peck
and receive the reinforcement quickly solved this problem.
The major drawback in using budgerigars is that ready made
equipment for their use is not available.

Previous work using the budgerigar (Ginsburg &
Nilsson, 1971) also used a discrete trial procedure and
had fairly short sessions.   The range over which responses
can be scheduled is not known at this time.   In the
Ginsburg and Nilsson study the final reinforcement
schedule used was a VR12 and session length was twenty
minutes.   It is probable that either length or rate
could be increased by decreasing amount of seed per
reinforcement.   In the present study the number of grains
of seed per reinforcement varied from 1 to 4, while in the
Ginsburg and Nilsson study a food cup was present for
2.5 seconds.   On the basis of these two studies and personal
observation it would seem likely that the birds would work

very effectively on an intermittent schedule with a minimal
number of grains of seed for reinforcement, and for a period
of time long enough to be useful in terms of data collection.
Perhaps it would be possible to use the budgerigar with
some other type of reinforcement than food; for example
bird song (Ginsburg, 1960; Stevenson, 1967, 1969).   It
is the case that, because of its size, the budgerigar is
quite sensitive to amount of deprivation of food.   The
range of percent body weight deprivation possible is
narrow, and outside of this range the bird simply does not
respond at all.